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Presidential Address

QUARANTINE IN DEFENCE OF AUSTRALIAN AGRICULTURE

A. G. STRICKLAND

The term quarantine is derived from the French word *quarante* meaning forty, and six centuries ago it simply referred to the forty day period of detention imposed on ships arriving from countries subject to epidemic human diseases. Its meaning is now much wider, and covers all the practices and procedures involved in shutting out, eradicating or confining pests and diseases which are injurious to man, animals and plants. For a more complete definition of quarantine it would be hard to better that recorded by the National Plant Board of United States in 1930. This said "quarantine is a restriction imposed by duly constituted authorities, whereby the production, movement or existence of plants, plant products, animals, animal products, or any other article or material, or the normal activity of persons, is brought under regulation, in order that the introduction or spread of a pest may be prevented or limited, or in order that a pest already introduced may be controlled or eradicated, thereby reducing or avoiding losses that would otherwise occur through damage done by the pest or through a continuing cost of control measures."

The Principles of Quarantine

At this time the National Plant Board also determined principles relating to the justification for quarantine restrictions and administrative procedures.

Recently these principles were restated briefly and without material variation by F. A. Soraci, Director, Division of Plant Industry, New Jersey State Department of Agriculture.*

In even briefer terms than those used by Soraci the principles were:—

1. A quarantine should have a basis in logic.
2. There must be necessity for it.
3. It must have legal sanction.
4. There must be validity and no deliberate hindrance of trade.
5. Public notice is desirable.
6. Restrictions must not be greater than those essential to attainment of the objective.
7. Co-operation of appropriate government authorities is necessary and that of the public must be sought.
8. The quarantine statement must be phrased clearly and simply.
9. The public should be advised of the reasons for and objectives of the quarantine.
10. Research aimed at increasing the efficiency of the quarantine is necessary, but need for research must not delay establishment of the quarantine.
11. There is an obligation to modify the quarantine as conditions or new facts warrant.
12. The quarantine should be rescinded or substituted by other measures if it is clear that it is not attaining the desired end.
13. Notice of quarantines must be given to interested parties, such as government authorities and organized public bodies.

Despite the lapse of thirty years, these principles are still sound and they provide a

* Soraci, F. A. (1957)—*Phytopathology* **47:** 381.

reliable guide to anyone concerned in establishing or administering quarantines. They provide also a basis for critical examination of existing quarantines.

Quarantine Practice

Although observance of principles is essential, the effectiveness of quarantine depends ultimately upon efficient practical application which in turn demands wise regulation, adequate qualified staff and satisfactory equipment.

Sound regulations are most important because restrictive action affords much greater protection than do measures based on inspection and treatment. In the long run, of course, legal restrictions cannot prevent every introduction of a pest. Fortunately, however, introductions often fail to establish themselves, and if they can be made infrequent, establishment can be delayed indefinitely.

Regulation of movement of plants, animals and materials must be varied in degree, according to the risks and likely consequences of movement of the pest which is feared. Sometimes total embargoes are justified. Such is the case in respect of protection of Australia from Blue Tongue. The latter is a most serious insect-borne virus disease of sheep, but may be carried without clinical evidence in bovine species. This circumstance has necessitated a complete prohibition against entry of ruminant animals to Australia.

In like manner certain plant material is completely barred from Australia, such as citrus plants or fruit from countries where Citrus Canker exists.

Where risks are smaller or the consequences of entry of a pest are less damaging, regulation of movement may be less stringent and subject only to such precautions as certification at the point of origin, detention after entry and treatment. Horses, for instance, may enter Australia from United Kingdom, New Zealand and Ireland without quarantine detention. Dogs and cats may be brought from certain countries subject only to detainment in quarantine for 60 days to ensure freedom from Rabies.

Many types of plant material may be permitted entry subject to certification in the country of origin, fumigation or other treatment on arrival, or growth in quarantine for a period sufficient to establish health.

The requirements for quarantine growth may even vary — from growth in an insect proof enclosure to cultivation in only relative isolation by a registered nurseryman.

As the major basis of efficient quarantine, regulations must be under continuous review in the light of new knowledge about the nature, distribution and control of various pests. In this connection, the World Reporting Services set up by the Food and Agriculture Organisation in relation to both plant and animal pests are invaluable in supplementing and co-ordinating the pest reporting activities of government departments and other institutions in many countries.

Staff requirements for quarantine fall into three main categories. These are administrative officers, concerned with policy and the framing and interpretation of regulatory measures; research staff which has the essential task of gathering, from both within and outside Australia, information which will guide both policy and practice of quarantine action; and finally the inspectors who examine plants and animals for the presence of pests, check certifications and supervise treatments and detentions.

These three staff subdivisions are interdependent and no quarantine service can be efficient unless each section is fully staffed and provision exists for co-ordination of their complementary functions.

Important as well considered regulations may be, effective quarantine must still depend largely on such physical activities as inspection, detention and treatment. These activities demand adequate facilities and equipment — animal enclosures, insect proof houses, fumigation plants, garbage disposal units, and so on.

These requirements must be provided at every necessary point, for a quarantine line is only as strong as its weakest point. Equipment and facilities must be kept up to date and adapted or supplemented to enable the use of the ever increasing flow of new materials and procedures for treatment of plants, animals and their products.

Progress in quarantine treatments does not always involve greater expense, as instanced by the advent of methyl bromide and plastic sheeting, at a time when establishment of many more costly vacuum fumigation plants seemed essential for our protection.

In both Commonwealth and state spheres, plant and animal quarantine are administered and practised as separate activities. This subdivision is logical, provided that it does not preclude recognition of occasional overlapping. Weed seeds are the concern of plant quarantine services, but unwise and unregulated movement of animals is an important avenue for their spread. On the other hand fodder can be a means of spreading both weeds and animal diseases.

Informing the Public

One of the principles of quarantine is that the co-operation of the public should be sought. The requirement has become more urgent as travel and the transport of goods have become easier and faster. Generally, the movement of plants and animals and their products through commercial channels is orderly and amenable to quarantine supervision. On the other hand the traveller who carries infected or infested plant or animal material is not readily detected. Protection against his dangerous, and often innocent action, largely rests in educating him and securing his co-operation.

With such end in view the Australian Agricultural Council approved in 1949 the initiation of a co-ordinated Australian Plant Quarantine Publicity Campaign. Contributed in agreed proportions by the Commonwealth and all states, a total of £90,000 has so far been allocated for this campaign, which has made effective use of a variety of publicity and propaganda media.

The achievements of Plant Quarantine Publicity will never be capable of accurate assessment, but there is clear evidence that it has been the means of reducing substantially the casual movement of dangerous plants and fruits both from overseas and within Australia.

There is no parallel of the Plant Quarantine Publicity Campaign in respect of animal quarantine. Probably there is not the same need because the risks are less within Australia, and animals cannot readily be surreptitiously entered from overseas. On the other hand animal products in such forms as food, wool samples, or feathers, are easily carried by overseas travellers and not so easily detected. If the general public were better informed of the risks and consequences of introduction of serious stock diseases through the medium of animal products, the task of Australian animal quarantine authorities would be lightened. Some information on quarantine requirements is given to travellers and immigrants before they leave for Australia, but more could be done. Another problem exists within Australia. Recent immigrants frequently receive through the post small quantities of continental delicacies which often represent serious animal disease risks. This is essentially a social and educational problem, which could be reduced by a campaign directed at migrants in this country, seeking their co-operation in asking their friends and relatives in Europe to refrain from sending these foods out to Australia.

Plant and Animal Quarantine in Australia

Quarantine has served Australian agriculture well, and relatively few of the world's numerous pests of animals and plants have gained establishment here. Quarantine has also checked, to a degree, the spread within Australia of the pests which we have.

However, in appraising the benefits of quarantine, it is wise to consider the substantial help afforded by Australia's relative isolation, and in the case of pests with limited establishment here, by many natural barriers such as the Nullabor Plain and Bass Strait. These former aids to our quarantines are becoming less and less effective as transportation becomes more efficient.

Not long ago there were only two channels through which pest-carrying plants, animals or materials could be widely distributed — railways and ships. The advent of motor transport and aircraft merely doubled these channels, but economic and social developments have multiplied by many times man's opportunity to travel and to move his plants, animals and goods.

These developments in transport and travel have played a significant part in our national progress, but in conferring advantages they have frequently created attendant difficulties. One such difficulty is the maintenance of effective overseas and domestic quarantines.

Our Outer Defences

Many of the damaging introduced pests and diseases of animals and plants in Australia entered in the early years of settlement and before quarantines were established by the states, or colonies, towards the end of last century. Thanks are due to the states, which individually carried for many years the responsibility of excluding plants and animal pests.

Not until 1909 did the Commonwealth Government become answerable for the protection of Australia, as a whole, against the introduction of diseases and pests affecting man, animals and plants. Even then the local administration and execution of Commonwealth animal and plant quarantine regulations was left with the State Departments of Agriculture, where they still reside.

The use of existing staff and technical resources of the states made possible effective and relatively inexpensive exercise of Commonwealth plant and animal quarantine functions. This situation remains, and if the states were to withdraw from these functions, the Commonwealth would be faced with tremendous cost for services which would be less efficient.

Inevitably, though, the arrangement for state implementation of federal quarantines involved some difficulties. Fortunately many of these difficulties have been resolved and the dual controlled machinery for overseas plant and animal quarantine is working with reasonable, but variable efficiency from state to state.

It is carrying, however, a steadily increasing load imposed by our expansion in population, in agriculture, in secondary industries and in transport facilities. Like any other sort of machinery it needs periodic checking and testing and ultimately it must be overhauled.

Overseas Quarantine for Plants

Some twenty years ago, an overhaul of overseas plant quarantine machinery was initiated by the Australian Institute of Agricultural Science. Inspired by a submission from the Australian Capital Territory Branch, the Second General Meeting of the Institute agreed to examine and report upon the Australian system of overseas plant quarantine.

This was one of the first projects undertaken by the Institute and it proceeded with commendable speed and thoroughness; a report, endorsed by all branches, being available to the Third General Meeting. Even so, the Institute did not present this report, as intended, to the Australian Agricultural Council. Before this could be done, the report was used as a basis for discussion by a Commonwealth convened conference on plant quarantine.

It remains to be said that in succeeding years most of the 1940 Institute recommendations relating to staff, regulations and equipment were acted upon by the Department of Health.

Our farming, fruitgrowing and forestry industries owe much to Australia's foreign plant quarantine service. Damaging and dreaded pests such as Fireblight of apples and pears, Colorado Potato Beetle, the omnivorous Golden Nematode and many others have been kept out. Some have penetrated the outer defences but have been localised, as in the case of Sirex, the wood wasp pest of pine trees, which is still confined to Tasmania.

Others became temporarily established, as did cherry leaf spot in the Mount Lofty Ranges of South Australia some ten years ago, but were eradicated successfully.

Protecting our Livestock Industries from Overseas Pests

Unlike plant quarantine, animal quarantine does not have to cope with an enormous number of host species and hundreds of thousands of associated diseases and pests. Nevertheless, the many alternate avenues of animal pest and disease entry multiply the problems of maintaining effective quarantines.

Animal quarantine involves much more than excluding or detaining animals, and, in fact, the live animal is not always the most serious quarantine risk. There is a bewildering array of animal products capable of carrying animal disease, and adequate control over

importation of such goods presents considerable difficulty. Commercial imports of such commodities as cheese, for instance, are safe to the extent only of the honesty and efficiency of the regulatory services in the country of origin. Uncooked or only partially cooked meats and meat products carried in passengers' luggage present a hazard, but perhaps the greatest risk is kitchen garbage from overseas ships, which may find its way to piggeries. Disposal of ships' garbage is a matter of immediate concern in the light of clear evidence that facilities and arrangements for its safe destruction do not exist at many Australian ports.

Insects of many kinds are potential carriers of animal disease and the increasing speed and volume of air traffic has focussed more attention on the danger they present. They are a particular concern also of those responsible for human quarantine and demand the most meticulous measures at international airports.

Animal quarantine is concerned also with the problems posed by symptomless carriage of certain diseases, such as Blue Tongue, referred to earlier.

As in the case of plant quarantine, a good measure of effective Commonwealth-state cooperation has been developed for operation of overseas animal quarantines. Periodic conferences of Commonwealth and state veterinarians have played a large part.

Over the years, some major exotic animal diseases have entered, such as dreaded Foot and Mouth Disease eradicated by the Victorian Government in 1872 and Rinderpest, which was stamped out in Western Australia in 1923. Unfortunately, however, several new diseases have gained establishment in recent years, the most recent being Infectious Rhinitis of pigs in 1959.

A development of major significance in the animal quarantine field is the joint Commonwealth-state legislation relating to Foot and Mouth Disease. Provision now exists whereby pooling of resources in eradication and payment of compensation is possible in the event that this dreaded disease enters any state.

Internal Quarantine

Internal quarantine involving both interstate and intra-state activities has been, in the main, a function of individual states, using their own legislation. From time to time there have been challenges of state quarantine actions on the basis of conflict with Section 92 of the Commonwealth Constitution. Also, in the past, some interstate quarantines appeared to be in conflict with the principle that there should be no deliberate intention to hinder trade. Despite these difficulties and the frictions they induced, our internal quarantines have been reasonably effective in preventing or delaying the spread of pests throughout Australia.

The Commonwealth Government also has powers of local or interstate quarantine and does, in fact, maintain several quarantines relating to movement of plants within Australia. An example is the prohibition under the Federal Quarantine Act of movement of apples, pears and quinces into Western Australia, designed to protect that state against the entry of Codling Moth.

There is room for speculation as to whether or not many of our internal plant and animal quarantines would be more effective if the Commonwealth exercised its statutory powers relating to such quarantines rather more widely than at present. Or as an alternative, the Commonwealth was more ready to enter into bilateral or multilateral arrangements with states in relation to such internal quarantines. Most often there is no relation between interstate borders and the accepted approximate boundaries of spread of insects or diseases. Surely the latter boundaries are the most logical ones for quarantine purposes.

This point is not entirely unrecognized as evidenced by certain recent joint Commonwealth-state ventures in the quarantine field. For instance, the Commonwealth Government and the South Australian Government have co-operated to free an area straddling Northern Territory and South Australia of Contagious Pleuro-pneumonia of cattle. The two governments have also shared the cost of facilities enabling the free movement of "clean" animals to regions in other states which are at present free from the disease.

Plans are also being discussed for multilateral Commonwealth-state action to progressively eradicate Pleuro-pneumonia from

Northern Territory and Queensland. Two other examples of mutually advantageous co-operation in internal quarantine matters are the Commonwealth participation in the war New South Wales is waging on cattle ticks entering from Queensland, and the special legislation relating to Foot and Mouth Disease.

One proposal for a combined Commonwealth-state attack on a national problem in the quarantine field is as yet unresolved. This is the proposal for a quarantine line between those areas where fruit fly is endemic and those where it does not exist except for sporadic and restricted outbreaks. There is clear evidence that these sporadic establishments result from movement of infested fruit and that they are and will continue to be eradicable unless their frequency ultimately exceeds the resources of the states concerned.

It is evident that Commonwealth participation in the field of internal plant and animal quarantines has been but tentative, and that examination is necessary to determine a positive Australian policy on the problem of spread of pests and diseases within the country.

As far back as 1935, during a discussion on quarantine by the Australian and New Zealand Association for the Advancement of Science, Professor K. H. Bailey, Professor of Public Law in the University of Melbourne, said "In the long run, I do not myself think that quarantine is a problem that can be dealt with effectively except on a uniform — and national basis". Doubtless legal considerations were the background of this remark, but repeated today and whilst still having legal implications, it should also have far more compelling relation to such practical considerations as survival of primary industries, their costs of production, and the retention of overseas markets.

Plant and Animal Quarantine for the Future

Properly constituted plant and animal quarantines in Australia are much younger than Australia itself. The fact that their achievements have been considerable arises partly from isolation and slow, limited transport, partly from the vigilance of those entrusted with quarantine administration.

Continued achievement in the fields of foreign and internal plant and animal quarantines will depend upon progressive adjustments in the light of new technical knowledge and against a background of ever increasing speed and volume in the movement of all living things.

The detailed nature of the necessary adjustments, whether related to policy, practice or facilities must be left to others to determine. But I think few would deny that adjustments, even some major ones, are necessary.

As to ways and means of securing careful examination of the quarantines that protect our primary industries, we should be mindful of the success which attended the Institute's project on Overseas Plant Quarantine in 1940. It was the fore-runner of a vastly improved approach to the organization and operation of that function.

It is believed that the Australian Institute of Agricultural Science should consider initiating in similar manner an examination of all aspects of plant and animal quarantine in Australia, seeking for the purpose the active participation of the Australian Veterinary Association.

Such action would achieve two things. It would establish closer ties between two professional organizations having many common interests and objectives. More importantly, though, it would ensure that the Institute had played its part in securing maximum effort in defence of Australia's agriculture.

Reviews

THE PRINCIPLES OF CONDUCTING VARIETY TRIALS INVOLVING SUBJECTIVE JUDGEMENTS

G. G. COOTE

Variety trials of various kinds are well known types of experiment and such trials have been in common use over a long period of time. When such experiments involve organoleptic tests the number of phases of a trial can be unusually extensive. The term organoleptic is used generally to refer to sensory tests made by means of humans as subjects on foods or beverages as stimuli; it has a broad meaning which goes beyond the gustatory and olfactory senses and includes the sensations associated with the various impressions of touch, such as texture, softness, toughness, particle size, etc. As organoleptic tests themselves need special thought, it is well to consider them as they relate to variety trials and examine the preparation for them through the various stages which follow the initiation of the field trial.

The purpose of a trial is to obtain evidence as to whether the varieties to be compared differ in respect of some particular property or properties. Since replicates of the same kind show experimental error because of the uncontrolled sources of variation, the final criterion depends on a comparison of the variation between nominally different varieties and experimental error. The latter is a measure of the variation between replicates or units of the same kind. In the trial the varieties are used on units of soil called plots which are chosen to sample fairly areas called blocks chosen for their homogeneity. The difficulty in obtaining these blocks as homogeneous as possible increases as the number of plots increases and this restricts the number of varieties which can be compared in an experiment unless some device of design can be introduced to overcome it. The heterogeneity in the experimental units which must be accepted is, as far as possible, commonly maximized between the "blocks" of homogeneous units and each of these blocks accommodates a replicate of the set of varieties. This is the set-up of the simple design known as randomized blocks. The function of the blocks is to ensure, as far as possible, that the varieties are compared under fair or equivalent conditions and the experimental error is kept at a minimum to make the test of varieties sensitive. While it is quite possible to use a more elaborate design in the field trial, for general purposes of illustration we can suppose that a randomized blocks design is being used.

However, it is noted in passing, that there may be circumstances when the number of varieties available is large and the quantity of seed available rather limited. This means that

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Mr. G. G. Coote is a Principal Research Officer, Division of Mathematical Statistics, C.S.I.R.O. *This paper was originally presented on December 7, 1959 to the Fruit and Vegetable Processing Committee, a committee set up by C.S.I.R.O. in 1949 to co-ordinate fruit and vegetable processing investigations by its Division of Food Preservation, and the New South Wales Department of Agriculture.*

it would take some time to produce the seed necessary for a full scale trial which might then have to cope with a large number of varieties. Such a situation can be dealt with by running a trial with small plots of a large number of varieties. Lattice designs are suitable for such trials and only small numbers of replicates are required. The amount of material produced would be limited but this would permit preliminary evaluation leading to elimination of the poorest varieties and the selection of the best varieties for the more extensive tests. Such early stage variety comparison needs special consideration but the general principles given here apply to such experiments.

Field Trials

It is assumed in this paper that only fixed lines or named varieties will be included in the variety trials, as there is little point in using unfixed breeding material.

In considering a variety trial it is generally found that the number of varieties to be included represents a restricted selection from those available. The question is how this selection is to be made and what principles are to be followed in doing it. Commonly, there are only certain suitable areas for producing the materials we wish to use and the variety trial should be made in a locality representative of this area. Hence, the varieties chosen should exclude any varieties which are known to be unsuitable for growing in the region concerned. There is, of course, the question of new varieties and it may be necessary to include one or more of these, even if its suitability for the area is not fully established. It may be that, of the varieties chosen, some are more suitably adapted to the conditions of the region than others. This may show in the health or yield of the crop and these things should be studied and taken into account. This may be regarded as a direct test of suitability of the varieties.

It is true that there are various seasonal conditions associated with a region and these vary from one year to another. Hence, the results of a trial for one season (period of the year) may not be quite the same for another season (same period of another year). Overall suitability for a region must sample the seasons, in effect, and hence replication in time is necessary. Furthermore, variation in conditions from one district to another in a region may be important and this shows that replication in place may be necessary. It is possible that there will be some differential response between the factors variety, place and time, and a study of the data for trials replicated in time and place would permit conclusions about these questions.

Considering now the various stages from growing to organoleptic testing, it is seen that several distinct factors are involved. These range from various agronomic characters such as disease resistance, yield and quality, through processing, which may be simply cooking, to organoleptic factors. It may be that not all varieties take the same time to mature or require the same processing treatment for best results. Differences of these kinds could introduce difficulties and possibly precise information on these points is lacking. If this is so it would be necessary to collect data to give the required information so that the various varieties are permitted to show their true worth. It is commonly true of canning, however, that the processing is imposed by bacteriological considerations and for this reason, this minimum has to be used on all varieties irrespective of whether some variation would be better for other reasons.

Processing the Product of Field Trials

It is convenient to assume that all plots give their yields at the same time or over the same period and these are available for processing as a whole or by parts at the same time. Suppose that all plot yields of each variety were bulked to obtain the variety estimates of yield. Although this would have the advantage of averaging out the effects of soil fertility and other uncontrolled variables on variety yield, it would make impossible any tests for difference in variety yield. The use of separate plot yields, however, would give fair values of variety mean yields over the experimental area and permit an analysis of the data leading to valid tests of significance about

yield. In this analysis there would be a line for blocks or replicates corresponding to some actual physical management of the plots or units in the field. This is correct analytical procedure and should not be ignored. If we assume that all plot lots are available at the one time and require the same processing, it may be possible to treat them together in the same processing procedure in a random way (say, for position in the retort and cooling stack). If then some measurement is to be made on these plot lots, they become available for analysis and correct procedure for this must be determined. It may be that although field blocks were not preserved in processing they may be important; this may be known *a priori* but if not the question could only be decided by a test on the data collected by a suitable design.

It may have been possible to do all the above processing in one step; on the other hand it may have been impossible but the separate block lots could have had common treatment. If we wish to use the data of our experiment to make inferences where processing is necessarily repeated (not common) then we should have used replication of processing in the experiment, even if it were possible to treat all units in one common processing. This is just as important as the growing of the variety plots in blocks in the field trial. The situation now is that there are blocks of plots in the field for certain good reasons, and the same blocks in processing; the blocks are to eliminate heterogeniety for field factors and also in processing so that two kinds of heterogeneity are superimposed on the replicates of plots and taking out a line for blocks in the analysis is right and proper for two reasons. The fact that the block correspondence in the units was the same for both factors has not complicated the analysis.

It would be possible to use blocks in processing without using the same blocks as were used in the field. This could be done by using a Latin square design so that rows correspond to field blocks and columns to processing blocks. Such an arrangement is unnecessary because it reduces the number of degrees of freedom available for the estimation of error. The use of one set of blocks for both field and processing variables would eliminate these sources of error just as well as a Latin square. If each plot had to be processed independently then it would appear that there are no processing blocks. In this case it is important to make the instrumental control of processing as accurate as possible. Analysis of the data would, in general, take the field blocks into account.

These principles are clear and only require application to any other additional factors which enter into the experiment. If, for instance, there were different types of can and no test of this factor was required, the types of can would be made to correspond with blocks already existing. Hence, the separate stages of the experiment have to be built up on the structure of all preceding stages and the organoleptic tests may be thought of as the final stage.

Subjective Tests

When considering the organoleptic tests it is convenient to assume that all previous stages of the experiment properly require a randomized blocks analysis and these blocks were the field blocks. Then, provided the tasting panel can deal with all the variety of lots of a block in one session of tasting, this is the obvious way to arrange the work. This is true whether the samples are scored or ranked. The reason for this is that the subjective judgments of sample differences are more precise when samples are taken on the same, as against separate, occasions. It may happen, however, that not all the variety lots of a block can be dealt with by the panel in a single session. This complicates the arrangement of a design which can be conveniently analysed and some of the possibilities are considered.

Suppose that there are nine varieties, A to I, in each of four blocks and that tasters can deal with three samples together in a session. Further, suppose that samples are scored and that panel mean scores for samples are available for analysis. Samples of the variety lots of each block can be presented in threes to

the panel in 12 sessions in the following sets:— ABC, DEF, GHI, ADG, BEH, CFI, AEI, BFG, CDH, AHF, BDI, GEC. Such a design is a balanced 3 x 3 lattice and has to be followed for each block. If all nine variety lots could have been evaluated by the panel at one time the analysis of variance would have taken the form:—

Varieties	8 d.f.
Blocks	3 d.f.
Error (varieties x blocks)	24 d.f.
Total	35 d.f.

The analysis now becomes that for a repeated lattice and there are 144 units because each variety lot from a block had to be presented in four sessions. This gives the following analysis:

Varieties	8 d.f.
Blocks	3 d.f.
Varieties x blocks	24 d.f.
Variety sub-samples x blocks	12 d.f.
Between sessions	32 d.f.
Within sessions error	64 d.f.
Total	143 d.f.

Thus a design for organoleptic tests may be consistent with, and superimposed on, that appropriate for the rest of the experiment.

The above type of design can be analysed for ranked data, subject to certain assumptions. Moreover, other orders of lattice, such as 4 x 4, may be used. Further, Latinized rectangular lattice designs to accommodate 3 x 4 = 12, 4 x 5 = 20, etc. varieties are available for scores. It is seen that these may involve a large number of sessions of tasting and may become prohibitive for this reason. Further, they accommodate only special numbers of varieties, such as 9, 12, 16, etc. and these with restrictions as to how many samples are presented in a session. It is possible to eliminate some of these difficulties; for instance, a trial with eight varieties could be done as a 3 x 3 lattice by running one variety in duplicate in tasting.

Other incomplete block designs may be used in the way illustrated above. These generally represent a greater amount of tasting than when all variety lots from a block can be dealt with together in a session. For purposes of illustration, suppose that five varieties A to E are available from each of four blocks and that four samples can be dealt with in a session and scored. The original randomized blocks analysis would be:—

Varieties	4 d.f.
Blocks	3 d.f.
Error (varieties x blocks)	12 d.f.
Total	19 d.f.

But the five variety lots from each block can be presented to the panel using sub-samples of four lots in each of five sessions in the following sets:—

ABCD, ABCE, ABDE, ACDE, BCDE.

The analysis of variance of panel means takes the form:—

Varieties	4 d.f.
Blocks	3 d.f.
Varieties x blocks	12 d.f.
Sessions	16 d.f.
Within sessions error	44 d.f.
Total	79 d.f.

Conclusions and Summary

All these special designs when used for scores involve complications of analysis due to non-orthogonality arising from the use of incomplete blocks. Further, there may be difficulties in checking on panel performance. If the basic design on which tasting is to be superimposed is completely random, the overall situation is simplified. If, however, the basic design is more complicated, such as a Latin square, the overall situation could be more complicated. It is clear that such situations require individual consideration in the light of the principles given.

If the yields of plots are borne over a period of time, this complicates the experiment in that the total yield is the relevant quantity which must be sampled and tested in the organoleptic test. Further, if the quality should change over this period this should be taken into account in an appropriate way.

It can be seen now what is required to conduct a variety trial through to the tasting

stage. Probably the quality evaluation so obtained must be studied with regard to other quantities such as yield. Further, the results as to replication in place and time must be taken into account. The decision as to whether the testing can be terminated has to be made in the light of all these results. If the testing indicates certain conclusions it would seem that these should be checked on a large scale to see that large scale results are consistent with experimental conclusions.

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Book Review

The Australian Environment

C.S.I.R.O. in co-operation with Melbourne University Press—third edition (revised) 1960, *Price* 30/-.

Although extensive revisions have been made to a few chapters, the most striking and pleasing difference between this and the earlier editions is the much more attractive format.

The maps, figures and photographs are presented in a more uniform manner and the changed page size (7in. x 9½in.) has enabled a much more attractive layout of chapter headings and illustrations.

The book provides a broad understanding of the history and present stage of development of the plant and animal industries in relation to their environment. In this revision, more recent information has been incorporated in a few chapters where this was necessary, but the main effect of the revision has been to obtain a more uniform presentation, and a much better balance with respect to length and the degree of detail of the material in the various chapters.

It should be of value to many people within Australia, but of particular value to people in other countries who are seeking a broad outline of the Australian Environment and sources of further information concerning those particular aspects in which they are most interested.

R. G. DOWNES.

A Review of the Biological Control of Insects and Weeds in Australia and Australian New Guinea

By F. Wilson

Commonwealth Institute of Biological Control, Technical Communication No. 1; 104 *pp. Obtainable from the C.A.B. Liaison Officer at* 314 *Albert Street, East Melbourne,* C.2., *Victoria. Price* 31/3.

This excellent review has been badly needed for a long time since the information on biological control in Australia and New Guinea is widely scattered in many different journals, and a great deal of it has only appeared in departmental reports. It has been practically impossible for Australian entomologists to check up on what parasites and predators have been introduced in attempts to control any particular pest or weed, or what success has been attained. The book consists of a comprehensive review of all the literature from 1894 to 1957, including many personal communications, and contains some 558 references; it is also very well indexed. Fifty-five insect pests and ten weeds are listed and a brief summary given for each, indicating whether or not the parasites have become established and what degree of control has been obtained. In addition there are two general summaries, one for insect pests and one for weeds in which the various species are grouped according to the degree of control obtained. The book will be most useful to entomologists in Australia and indeed throughout the world and the author is to be congratulated on a remarkably thorough and well presented piece of work.

A. R. WOODHILL.

DATE GROWING IN AUSTRALIA

URSULA DE FONTENAY and
V. J. DE FONTENAY

The fruit of the date palm (*Phoenix dactylifera* L.) has been the staple diet of the natives of many parts of the Old World since the beginning of history, and it has been claimed to be the earliest domesticated fruit. Its original habitat is not definitely known, but records of its cultivation in Mesopotamia (Iraq) extend as far back as 3500 B.C. Date culture was introduced into the Saharan oases towards the end of the Roman Empire and was further stimulated by Arab invasion during the seventh century A.D. (Nixon 1951).

In the Middle East the date palm has many other uses besides providing food and drink. The trunk and leaf bases of the date palm are, in many places, the only source of fuel; the trunks and leaf stalks provide timber for bridges and house uprights; the leaf stalks are also used for crude furniture and fences.

TABLE 1

Country	Number of palms (millions)	Export Year	Tonnage Short Tons
Iraq	17.7	1948	238,000
Arabia	8.0	1949	11,000
Algeria	6.9	1949	24,000
Iran (Persia)	6.0	1949	34,000
Egypt	5.3		
Libya	3.0		
Pakistan	3.0		
Morocco	2.9		
Tunisia	2.5	1949	4,374
Sudan	1.3		
U.S.A.	.3		
Spain	.2		
Total	57.1		311,374

Source, Nixon 1951.

The leaflets are used for weaving mats, baskets and hats; and the fibre from around the leaf bases is often used for mattresses or woven into a rough rope. The seeds, when burnt, provide a charcoal valued by silversmiths.

Date Growing Countries of the Old World

Iraq leads the world in date production, and with Persia (Iran) and Arabia combined would contain about half the total producing date palms in the world. Despite their production Egypt and Pakistan are large importers of dates.

Date Culture in the New World

Spanish missionaries first took the seeds of the date palm to the New World towards the end of the eighteenth century, where they planted them around many of their mission houses in the southwest of the United States and in Mexico. In 1947 a few of these original palms were still standing. The moist climate of the coastal areas did not favour ripening, and later seeds were planted in the hot, dry interior valleys of California and Arizona. As these seedling palms came into bearing, interest was aroused as to the possibility of commercial production. The United States Department of Agriculture first imported offshoots in 1890, but when the palms fruited they were found to be inferior types. Beginning in 1900, the Department of Agriculture

Ursula and V. J. de Fontenay are the owners and operators of "El Mima" date garden, Alice Springs, which, to our knowledge, is the only existing commercial date garden in Australia.

sent plant explorers to the date growing countries of the Old World to obtain offshoots which were true to type. In Arizona, because of lack of knowledge of the cultural requirements, very few of these offshoots survived, and for the next 25 years little interest was taken in this field of fruit production in that state. (Thornber 1925).

In California the first experimental date garden was planted at Mecca in the Coachella Valley in 1904. Three years later headquarters for experimental work were transferred to Indio, also in the Coachella Valley. Research at Indio has greatly increased the scientific knowledge of date culture, and of the conditions necessary for optimum fruit production and when date growing was established as an industry in California there were men qualified to direct the growers and prevent many and costly mistakes.

The successful establishment and continuing prosperity of the date growing industry in California is largely due to research carried out by such men as Swingle, Kearney, Mason, and Fawcett, in the early part of the present century; and in the past 30 years, to Roy W. Nixon and associates of the United States Date Field Station at Indio, California, and to pioneer private growers like Bernard G. Johnson who went abroad and collected offshoots for commercial plantings in 1903. Johnson also produced some of the first commercially grown dates of imported varieties in the United States. Later private growers made further imports of approximately 43,000 offshoots between 1911 and 1922.

The present day Californian methods of date culture have resulted from continual experimenting to improve the quality and yield of fruit. In California the palms are planted 30 feet apart (49 to the acre) compared with up to 125 palms to the acre in the Middle East. Palms in the Old World often produce about 80 lb of fruit per palm, whereas in California with better husbandry, and soil and water conditions, the same variety yields 250 to 300 lb per palm. Figures for production in the Old World are hard to come by but Dowson (1926) reports that the average yield per palm at Basra, Iraq is about 50 lb.

About 90 per cent. of the date production of the United States and 95 per cent. of the Californian production comes from the Coachella Valley. The total Californian production in 1955 was 48 million lb.

Date Culture in the Southern Hemisphere

Very little has been written about attempts at date culture in the Southern Hemisphere, and Dowson (1921) and Nixon (1951) merely record that attempts have been made to grow dates in South Australia, Queensland and New South Wales.

South West Africa

In the northwest corner of the Union of South Africa there is now at least one thriving date garden called Henkries Date Grove. It is on the north side of the Koa Valley, in part of the Steinkoph Coloured Reserve. The area is hot and dry with a rainfall of less than two inches per year. Subterranean water is plentiful, and although extremely salty, occurs at times only 12 inches below the surface. The plantation consists of seedling palms, and in 1945 an area containing about 100 mature palms was enclosed by fencing. After 12 months of cultivation these 100 palms produced 1500 lb of fruit. By 1955, the planting had extended to 2000 palms, plus 400 seedlings grown from seed imported from Indio, California. This plantation is sponsored by the South African Division of Coloured Affairs. (Smit 1955).

Australia

Date palms, whose origin is obscure, can be found at many old homesteads in the northern, central and western portions of Australia. Possibly these palms grew from seeds either planted or tossed aside by early travellers and settlers. They are usually found near wells, bore drains, or water holes, where natural conditions have favoured germination and growth. At odd times during the past 50 years attempts have been made to set out plantations, but because of lack of knowledge of cultural requirements, and the consequent high mortality rate most attempts have failed and there remains few printed records of these ventures.

Northern Territory: Baron von Mueller (1885) eulogised the usefulness of the date palm and claimed that he first introduced the palm into central Australia. It is known that he sent seeds to the Hermannsburg Lutheran Mission in the early 1880's in return for the numerous specimens of native flora which the missionaries had collected for him. There are at present at Hermannsburg about 80 palms which grew from these original seeds, but, as is common in a seedling garden, a large percentage are male palms, and the quality of the fruits of the female palms varies considerably. No attempt has been made to cultivate the palms as a commercial undertaking, and the fruit which is harvested is used solely by the inhabitants of the mission.

South Australia: In 1890 a small garden near a bore at Hergott Springs (now Marree) was placed at the disposal of the Forests Department of South Australia for experimental purposes. The reports made to the Forests Department over a period of 25 years (Anon 1889-1916) cover mainly the number of seeds planted and palms growing during these years.

The site at Hergott Springs was at first thought to be ideally suited for date growing. Apart from the mound springs, there was a bore whose water contained 0.29 oz salt per gallon, which at that time was compared more than favourably with the Oued Rir (French Sahara) where the water contained 0.57 oz salt per gallon.

During the first two years over 600 seeds were planted, and after germination of a number not quoted, 68 died. The author of the reports (*Anon*) decided that a better soil could perhaps be found further afield, and he chose the site of Lake Harry, about 20 miles east of Hergott Springs for future plantings.

In 1892 236 offshoots were imported from "Kurrachee" (presumably Karachi) in India and planted at Hergott Springs. Only two remained alive two years later. The varietal names of these offshoots are not recorded.

During 1894 a shipment of 52 Deglet Noor offshoots arrived from Biskra as a gift from the French Government. These offshoots were planted at Lake Harry, and 45 survived and later produced fruit.

In 1902, at the peak of the experiments, the Hergott Springs plantation consisted of 279 palms, and the Lake Harry plantation 3,300. These numbers gradually declined each succeeding year. The author of the reports attributed the decline to (a) high mortality rate of seedlings, (b) lessening of bore water flow, (c) poor water and soil and (d) the fact that many seedling palms had to eventually be culled because they were either male palms or poor quality female palms. Even well established palms commenced to die off, and the present authors think that this could have been caused by poor drainage allowing a high salt concentration to occur.

In 1914 it was decided that better soil and water could be found along the River Murray and all but four of the imported Deglet Noor palms were removed to the Murray Irrigation area (Berri Experimental Farm and the Cobdogla-Lake Bonney Irrigation channels). In the following year, due to a long dry spell and constant sand storms, the sites at Hergott Springs and Lake Harry were abandoned. The Lake Harry plantation was buried by sand almost to the top of the fences. Today at Lake Harry, four Deglet Noor palms stand tall and gaunt, together with odd clumps of palms of unknown origin (possibly seedlings) surrounded by several generations of offshoots, while at Hergott Springs the sole survivor is a palm with a small tuft of stunted leaves and a large hole in the trunk about six feet from ground level.

In 1958 one of the authors (V. J. de F) visited the sites of the old Cobdogla-Lake Bonney Irrigation channel (now Barmera S.A.) and traced some of the palms which had been moved there in 1915. Only one, growing beside an irrigation ditch, still carried offshoots. Permission was obtained to remove all six offshoots and they are now growing in the El Mima Date Garden.

Queensland: In 1937 the Queensland Department of Agriculture planted a number of imported date seeds at Biloela in Queensland. The

following year the seedlings were transplanted to some districts in western Queensland, including a large plantation in the form of a single line grove on either side of a driveway at Rayford Park near Miles. The soil at Rayford Park, typical of much of the western plain country, is a grey sandy loam overlying a heavy clay subsoil. The rainfall is approximately 25 inches per annum, falling mainly between January and April.

The seedlings produced about 50 per cent. each of male and female palms with a total of 75 palms in the grove (Richardson 1952). No offshoots were permitted to grow because it was believed that they would weaken the parent palms and so even if some of the seedlings eventually produced good fruit their continuity was doomed.

This project seems to have been an experiment to show that dates could grow and ripen fruit in given areas in western Queensland but since no offshoots were permitted to grow and there is no report of further seed plantings, it can only be assumed that the experiment had served its purpose.

Katherine, N.T.: During the wet season of 1952-53 a number of imported seeds were planted at the C.S.I.R.O. Research Station at Katherine (rainfall 35 inches per annum). This experiment was conducted in conjunction with the Plant Introduction Section of the Northern Territory Administration. When transplanted into the field most of the seedlings died and the remainder were left in the nursery, and in 1958 no further experiments were planned.

Gascoyne, W.A.: In 1952 a number of offshoots from established seedling palms were planted at the Gascoyne Research Station near Carnarvon in the far northwest of Western Australia. The Department of Agriculture in Western Australia also obtained ten named variety offshoots from California in December 1952. Four of the palms had died by 1958 and one had produced a small amount of fruit.

El Mima Date Garden—Alice Springs

In February 1950, the authors were given a bunch of dates from an old, neglected palm which grew on a vacant allotment in the centre of Alice Springs township. Although the fruit had been only wind-pollinated, the flavour was far superior to that of the imported cured dates of commerce. The fact that the palm in question was producing fruit despite lack of cultivation or surface water suggested that orchard husbandry should improve both quality and yield. So the idea of producing dates on a commercial scale was formed.

Search for Information

Australia: Enquiries to the State Departments of Agriculture revealed that at that time (1950) no department had any first hand information on date culture, excepting Queensland where the Rayford Park Grove had been growing for 13 years.

Professor J. A. Prescott (private communication 1950) advised that the only satisfactory method of propagating date palms was from suckers—or offshoots—from selected palms.

Middle East: The only literature available from the date growing countries of North Africa was written in French, and the export of offshoots from all these countries was prohibited.

United States of America: The information gained from California was invaluable. The comprehensive record of over 30 years practical and scientific experience and the willingness of date growing pioneers there to discuss their problems and to record data enabled the authors to avoid many of the mistakes made in the early days of date culture in the United States and in Australia.

Collecting Offshoots

In Alice Springs and surrounding areas 32 palms were discovered in backyards, vacant allotments, and alongside old wells, springs and watercourses. There were twenty female palms and 12 male palms. In the following two years the female palms were pollinated to discover their commercial potentialities. Each of the twenty female palms produced fruit differing in quality, size, shape, colour

Figure 1—Young date palms at El Mima date garden, Alice Springs.

and time of ripening. Fifteen were finally selected for further trials. Eight of the 15 selected have since been successfully transplanted to El Mima—their ages ranging from 15 years to 60 years (these ages are conservative and allow for shortness of human memory), and offshoots of all 15 now form a large portion of the present planting in the garden.

In May 1952 Mr. F. J. S. Wise, Administrator of the Northern Territory, offered to obtain some offshoots from the far north-west of Western Australia; as it happened the offshoots were off-loaded from the ship en-route and died before eventually reaching Darwin.

In 1952 the owner of a large date garden at Indio, California offered a gift of 100 named variety offshoots but freight charges were prohibitive (£25 each) and only 12 offshoots were eventually obtained. Two were air-freighted and planted at Alice Springs on December 19, 1953—five days after leaving Indio. Ten were shipped to Sydney then railed to Alice Springs, arriving June 3, 1955—six weeks from leaving California. Nine of these offshoots are now thriving and 5 have produced at least one bunch of fruit. The loss of the other three offshoots could have been caused by the repeated fumigations endured (California, Sydney and Adelaide).

The six offshoots from Barmera S.A. (see above) are also now growing well.

Today the El Mima garden contains 135 palms.

Mature seedling palms—originals—transplanted	8
Offshoots from the 15 selected local palms	112
Deglet Noor offshoots from Indio, California	9
Deglet Noor offshoots from Barmera ex Lake Harry	6

At the close of 1958, these 135 palms carried 350 offshoots of varying stages of growth.

From the first successful plantings in 1953, monthly records have been kept of the development of each individual plant in the field. Some palms produced offshoots in preference to fruit bunches in the early stages; others grew rapidly in height—from 42 inches to ten feet in the first four years, but produced few flowers or offshoots in this time. Some offshoots which did not reproduce themselves in the early stages, flowered for the first time

Figure 2—Ripening fruit protected by plastic covers.

23 months after being planted in the field. All the variations seem to be varietal characteristics.

Botanical Features

The date palm, *Phoenix dactylifera* L. is one of the most important members of the family Palmaceae. A number of the genus Phoenix are well known for their ornamental value.

Trunk

The date palm attains a height of 60 to 80 feet or more (Mueller (1885) claims 80 to 100 feet as common) and has been known to live for 100 to 200 years. As the palm reaches excessive age, the leaves tend to become shorter and the fruit correspondingly smaller. This makes it difficult to correctly classify the variety of old palms. The trunk has excellent insulating properties. Mason (1925) has shown that internal trunk temperatures may be 26°F higher than the surrounding air temperatures on the coolest morning and 32°F lower on the hottest day.

Root System

The root system is fibrous, with many adventitious roots arising from the base of the trunk and penetrating the soil diagonally and vertically to depths of 20 feet or more (Simmons 1926). It has been claimed that the roots of the date palm do not have hairs, and that this absence makes them especially adapted to live in water for considerable lengths of time.

Leaves

The leaves vary from about 10 to 24 feet long and carry several hundred pinnae or leaflets. Towards the base of the leaf stem are several sets of stunted pinnae or spines, the number and placing of these pinnae can be characteristic of a variety. The small stomata are sunk below the leaf surface in small pits. Altogether the structure of the above ground portion of the date palm is peculiarly adapted for drought and heat resistance.

Flowers

The date palm is dioeacious. The inflorescence is a branched spadix which arises from the axils of leaves produced during the previous year. It is protected in the early stages of emergence by a hard, rough spathe, which when first sighted, pushing up close to the leaf stem, is pale green, but soon becomes brown as the spathe extends.

The inflorescence and stem of the female flower is often 18 to 20 inches long at emergence increasing to 24 inches in full bloom and consists of from 60 to 145 long strands. The small florets are grouped irregularly along the strands; they are globular in shape and almost pure white in colour. Each floret contains three carpels, but after pollination, only one of these remains to mature into a seed bearing fruit.

The male inflorescence is more showy than the female and carries many strands varying in lengths from 5 to 11 inches, which in turn bear thousands of tiny, ivory coloured florets. One male palm at Alice Springs averages 350 strands, each of 80 florets per inflorescence. In 1958 this palm carried 20 inflorescences, making a total of 560,000 individual florets for the palm*.

A good male palm produces large quantities of pollen and the distinctive pollen odour is present even before the spathe splits.

* All measurements quoted for numbers of flowers and stem lengths are averages taken at Alice Springs during the past four years.

Pollination

Hand pollination has been practised through the centuries and, without it, wind pollination provides only a poor set of fruit. Dates which are not pollinated set poor quality seedless fruit. Pollination can be done either by shaking a male inflorescence over the female inflorescence; or by inserting a sprig of male florets into the female inflorescence. Both methods are successful, the choice is an individual matter of ease and economy.

Nixon (1926) found that the pollen did not noticeably alter the quality of the fruit, but did influence the size and time of ripening.

A good male palm can produce sufficient pollen to hand pollinate about 50 female palms, whereas with wind pollination, at least one male would be needed to each female palm. Even then the set of fruit might occur only on the side of the palm nearest to the male.

Propagation

The only satisfactory means of propagating a palm true to type is by taking offshoots. Offshoots usually appear during the first ten to fourteen years of the palm's growth from axillary buds which usually occur at the base of the palm, although some varieties consistently produce offshoots three to ten feet up the trunk.

In Iraq the offshoots are taken when they are about six inches in diameter and weigh approximately 30 lb (Dowson 1926). In California the offshoots are more often eight to ten inches in diameter and weigh up to 75 lb. The difference in sizes appears to be a matter of local choice. At Alice Springs we have found that successful results depended, not so much on the size and age of the offshoot planted, as on the manner in which it was cut from the parent. Offshoots as small as 6 lb weight have survived.

Types of fruit

Dates are classified into three types depending on the composition of the mature fruit. Each variety produces fruit of one type only.

Soft: The soft date has a high moisture content when picked and is subject to mould in a few weeks if not pasteurised or cured.

Semi-dry: This type has a slightly lower moisture content when picked; is often a mid-season ripening fruit, and at Alice Springs is noted for its firm, almost unwrinkled appearance and will keep for up to three months in a household refrigerator without any treatment.

Dry or bread date: This type has a high sugar content and low moisture content. In the Old World date growing countries it is highly valued because it can be carried for long distances, packed in sacks, without curing. In some cases it is the only food available to the natives of these countries. These dates are not usually considered as a commercial possibility in European countries, being tough to chew, and often having a poor, wrinkled appearance.

At Alice Springs the natives have shown a partiality for the bread date and request it in preference to the soft and semi-dry types.

The varieties grown at Alice Springs cover the three types as described above, and it is felt that all types will have a place as future commercial possibilities.

Pasteurising and Curing

Generally speaking curing is a form of drying in which the soft fruit, semi-dry and dry are often set out together on matting to be dried by the sun, and then packed tight in boxes for export. The commercial date that we know in Australia has always been cured.

Pasteurisation on the other hand is a process in which fruit is held in especially controlled temperature rooms (depending on variety and moisture content) until partial dehydration of excess moisture takes place.

Varieties

Overseas varieties have been described by Nixon (1950). He lists 16 major commercial varieties in detail; 29 minor varieties; and gives brief descriptions of 105 others. These 140 varieties were imported into the United States during the first quarter of the present century. Many which were highly prized in

their country of origin, were found to be unsuitable in the United States, and of the sixteen major varieties quoted, the Deglet Noor has been propagated more than any other variety and now accounts for 80 per cent. of the palms planted in California. Nixon (private communication) has suggested that all imported varieties have some drawbacks, and an attempt is now being made in the United States to select locally grown seedling varieties which may be an improvement on the imported ones.

In Alice Springs, of the 15 varieties growing at El Mima at the end of 1958, it is thought that perhaps only six or eight will be selected for eventual propagation because each variety requires individual treatment in pasteurising, and also because some varieties bear fruit sooner than others; some produce very few offshoots; and some bear only 60-80 lb of fruit as compared with the 150-250 lb weight of other varieties.

At this early stage it is not an economic proposition to spend too much time or water on one variety which is bearing only 60-80 lb, although the fruit quality is very superior. On the other hand, another variety produces 200 lb weight of dry dates which could be successfully used as by-products for flavourings, etc., even if there was little demand for the fruit as such.

Some of the best fruits at El Mima come from varieties which were well beyond the offshoot producing stage when the venture began, and in one case only two small offshoots were saved—these offshoots now carry fifteen smaller offshoots so that the variety has not been completely lost. Another good quality, high yielding variety was 60 years old when selected and carried only one very small offshoot—6 lb weight—which as yet, has not reproduced offshoots of its own.

To prevent further losses of what could be promising varieties, it is considered of great urgency that a survey be made of, and if possible offshoots collected from existing palms throughout Australia. Each seedling palm represents a new clone. If it is worthwhile, yet lost because no one bothered about its future potentialities, any date industry of the future would be poorer for the loss. And as happened in the United States of America, thousands of pounds and many years might later have to be spent to import and propagate varieties.

Climatic and Other Requirements

Much that has been written about the climatic requirements for the successful culture of the date palm is conflicting, and because there has been no research work in Australia what follows has largely been sieved from the available literature. Some varieties will ripen in environments with climatic conditions entirely unsuited to other varieties, so that an individual variety is just as important a requirement for successful ripening as are the other necessary climatic adjuncts. For instance the Deglet Noor variety when grown in the Sudan ripens as a dry or bread date, whilst in the United States, with a greater water supply, it becomes a semi-dry type—more agreeable to the taste of the European.

The critical climatic factors for the successful ripening of the date are, high temperatures during ripening; lack of rainfall during ripening; and low relative humidity at critical stages of ripening.

Temperature

The date will not produce flowers and fruit when the temperature is below 64.4° F, and much higher temperatures are required for successful ripening (Swingle 1901, Kearney 1906). Swingle and later authors have used the number of heat units taking 64.4°F as the zero mark to compare the temperature characteristics of different regions. Kearney points out that the sum total of daily mean temperatures (above 64.4°F) gives a different picture from the sum total of the daily maxima. The results between the two summations can represent a difference of heat units of up to 2000 degrees. However it seems obvious that whether comparisons are made between average daily mean temperatures or average daily maxima, of given date growing localities, a workable conclusion can be reached. Table 2 shows the heat units computed both ways for selected date growing regions.

TABLE 2

Summation of heat units above 64.4°F during ripening at localities in Tunis and Algeria as compared with California and Alice Springs.*

Locality	Sum of average daily means	Sum of average daily maxima	Remarks
Tozer, Tunis	3555.5	5818.5	All varieties including Deglet Noor ripen perfectly.
Nefta, Tunis	3277.7	5710.4	as above
Gabes, Tunis	2272.7	3936.5	Finest varieties do not ripen well.
Biskra, Algeria	3304.0	5489.0	Many varieties ripen perfectly.
Indio, California		6488.8	Deglet Noor is main variety and ripens perfectly.
Alice Springs, Australia		5350.0	All local varieties ripen well. Deglet Noor not yet fruited sufficiently.

*The period summed is the six month period from pollinating to ripening (mid Sept.-mid March in Alice Springs).

Source, Middle East (Kearney 1906).
U.S.A. (Nixon and Moore 1957).
Alice Springs (Comm. Met. Bur. Alice Springs).

Absence of Rainfall

The fruit of the date has definite ripening stages which are classified as follows:

1. *Chimri*: the fruit is small, green and unfit for food.

2. *Khalal*: approximately 20 weeks later, the fruit is the same shape as a mature fruit, has attained its deepest colour of red or yellow depending on variety.

3. *Rutab*: Between three and four weeks later (at Alice Springs) when the apex of the fruit becomes soft and brown.

4. *Tamar*: Two to three days after Rutab at Alice Springs—perfect ripeness; the fruit becomes brown of various shades according to variety.

The effect of rain seems to be most critical during the khalal stage. At this time, if the rainfall is prolonged it can, depending on the variety, cause the fruit to shatter by means of longitudinal splits. The flesh curls back and the fruit is completely ruined. Rains just before the khalal stage can cause checking in fine horizontal, longitudinal or irregular scratchlike lines around the apex of the fruit. These lines do not disappear, but remain as permanent scars. The variety Deglet Noor is highly susceptible to these disorders and is not to be recommended in an area where rainfall is at all likely during the khalal period. Once the tamar stage is reached, rainfall cannot affect the fruit unless harvesting is delayed then mould can become established. At Alice Springs, where rain is likely at any time of the year, during the past six years in which fruit has been harvested, damaging rain has occurred only on one occasion during a critical period. The reactions of seven varieties is shown in Table 3.

TABLE 3

Rain tolerance of varieties grown at Alice Springs.

Local variety	Rainfall during critical stage	Remarks
101/JC	Once in six years	Rain tolerant
113/I	Once in six years	Slight to heavy checking
102/AM	Once in six years	Rain tolerant
125/MB	Once in five years	Slight checking
107/T	Once in five years	Mould under calyx of ripe fruit left too long on palm
112/D	Once in five years	Slight shatter
106/M	Once in five years	Checking

The remaining varieties have not been observed long enough to comment.

Low Humidity During Ripening

Very dry conditions are important for the successful ripening of dates. The absence of such conditions usually prevents the dates from ripening in coastal areas. At Alice Springs, humidity high enough to damage fruit does not always follow rainfall at critical ripening periods, and the average relative humidity, 26 per cent. during ripening months of January, February and March, is usually not high enough to cause damage.

Soil

Dates are grown on a wide variety of soils. The maximum water-holding capacity consistent with good drainage seems to be desirable. Klee (1883) claimed that:—

"The date palm grows and flourishes . . . in a soil too poor and too purely alkaline for other fruit trees, and it produces the finest and best flavoured fruit nourished by water too alkaline for man or beast".

On the other hand Nixon (1945) writes "although dates will grow on soils containing more alkali or salts than many other plants will tolerate, observations in the southwest (U.S.A.) indicate that the best palm growth and fruit quality cannot be obtained under relatively saline conditions".

Generally speaking it seems that different varieties have their individual preferences for certain types of soil, which range from pure sand, through light, medium and heavy soils. Kearney (1905) writes of good quality dates growing in pure sand in the Oued Souf region of Algeria, while Dowson (1921) states that the date gardens of Iraq are usually to be found in limestone ridges.

The soil on which the palms are grown at Alice Springs is a loamy sand, river bank soil on which cabbages, lettuce, carrots, beetroot, potatoes and citrus fruits grow to perfection.

Water

It is repeatedly claimed in Australia that dates require salt water for successful development. This notion is rejected by Frank M. Eaton (1937) a physiologist in the U.S.D.A. Bureau of Plant Industry who in discussing salt problems in arid regions says:—

"Few if any agricultural plants are thought to be more tolerant to salt than the date palm. Both Swingle and Kearney observed its growth in Northern Africa on very saline soils. Both investigators were impressed by the responses of trees following removal of a part of the salt from the root-zone. Swingle points to the cultivation of the palm under conditions he thought would preclude other profitable cultures. He states that old date palms which had made a slow and stunted growth and which had fruited but little, at once grew luxuriantly and began to bear heavy crops when a 'remarkably

pure' irrigation water was substituted . . . The date palm does not thrive best on, nor so far as we know, derive benefit from quantities of salt that are detrimental to other cultivated plants of desert areas".

Samples of water used at El Mima were analysed by the Animal Industry Branch, N.T. Administration, Alice Springs and showed an average total salts content of approximately 0.08 oz per gallon.

Cold

Mason (1925) found that the date palm ceased leaf growth at a temperature of 50°F, but that even if the minimum temperature falls well below freezing point, leaf growth may continue if the maximum temperature for the same day rises above 50°F (zero growing point).

In California, temperatures as low as 13°F have been recorded in date growing areas, and it was found that after these, although some leaves died on mature palms the palms suffered no lasting damage. The young palms and newly planted offshoots were affected most of all, some losing almost 100 per cent. of their leaves.

At Alice Springs, the lowest temperatures recorded since the commencement of records in 1888 was 19°F in July 1948 and the lowest temperature since El Mima garden was established in 1950 was 25.2°F in July 1952.

Pests and Diseases

So far neither pests nor diseases have been noted in the date garden at Alice Springs. Strict quarantine measures are enforced on the importation of offshoots into Australia but it is possible that pests are established on date palms growing in other parts of Australia and it now remains for the various states of the Commonwealth to prevent, from the start, the unsupervised carrying of offshoots between states.

The major pests and diseases found in date gardens in the United States have been described by Stickney, Barnes and Simmonds (1950).

At Alice Springs birds have been the only nuisance encountered. Various types of covers for the fruit bunches are being tried to stop the birds. At first the bunches of fruit were covered with muslin bags, but the birds pecked through these. Later plastic covers were used and these appear to be an improvement on the muslin although mould will quickly develop if free air circulation is not provided within the covers.

Conclusion

During 1956-57 Australia imported approximately 12,864,735 pounds weight of cured dates at a cost of £351,920. Fresh fruit of the type now being produced at El Mima has been hitherto unknown in this country, and would not have to compete with the imported product for many years to come.

The specific climatic requirements for successful growth and ripening of the fruit must be thoroughly understood and the information about all phases of date culture must be comprehensively tabulated before any farmers are encouraged to spend large sums of money on date growing.

The first eight years at El Mima have adequately shown that a fresh fruit of fine quality can be produced. If the industry is to expand there is need for a long term programme of experimental plantings, by government, or by private enterprise subsidized by the government, to find those varieties most suited to given areas and then to build up large numbers of offshoots of these varieties for further plantings. A similar need was foreseen by Swingle (1904) for plantings in the United States when he wrote:—

"The importance of a detailed study of the climatic and soil requirements of the date palm is clearly shown in treating of regions adapted to its culture, as well as in the discussion of the heat requirements and of the alkali resistance of this remarkable plant. It is also possible from the study of the life-history factors of the date palm to warn intending planters against attempting its culture in regions where it can not succeed. Thus it becomes possible to establish a new fruit industry in a rational manner without having to wait the tardy results of costly and often badly conducted trials without adequate foreknowledge of the requirements of the plant . . . Careful planned demonstrations in suitable localities in co-operation with skilful planters will take the place of haphazard testing by experimenters".

Forty years later, after much practical experience, Nixon (1945) reviewed these remarks thus:—

"The date palm is so different from the fruit trees with which new settlers are likely to be familiar that information concerning its peculiar cultural requirements must be available before it can be grown and fruited successfully".

Acknowledgements

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Errata

Volume 26, No. 1, Page 77.
Lines 5 and 6 should read —

A series of talks given by Officers of the Queensland Department of Agriculture and Stock at Toowoomba to a meeting of the Queensland Branch on October 28, 1959.

Volume 26, No. 2, Page 107, Paragraph 2.
The Australian Veterinary Journal was first published in 1925 not 1938 as stated.

THE SELECTION AND ESTABLISHMENT OF PASTURE SPECIES IN A SEMI ARID ENVIRONMENT—AN ECOLOGICAL ASSESSMENT OF THE PROBLEM

O. B. WILLIAMS

Introduction to the Problem

For more than 50 years, the establishment of exotic pasture species, or the re-establishment of indigenous pasture species in a semiarid environment, has been regarded as a difficult and unrewarding procedure by agronomists and pastoralists. In fact, Davies (1940) considered that "in the semiarid pastoral areas, on which the carrying capacity is below a sheep to 1.5 acres, the prevention of deterioration of the plant cover by exploitative grazing is the most important phase of pasture research". Whittet (1940) drew attention to the importance of the ". . . introduction and testing of drought-resistant species of forage plants from other countries, and the problem of re-establishment of semiarid and arid native pasture plants . . .". Donald (1941, pp. 40-41) set out some of the difficulties in the way of introducing exotic plants to a dry environment.

In a later paper, Davies (1951) referred to the lack of substantial success when indigenous species were sown, and pointed out that "our efforts to exploit our endemic species have been sadly disjointed, and the more spectacular and immediate benefits accruing from the exploitation and building up of our introduced species have been allowed to reduce our efforts with natives almost to vanishing point."

It is a salutary lesson to note that the possible use of exotic or indigenous species in low rainfall areas had been discussed in similar vein some 50 years earlier by Turner (1891).

Even in 1868 (*Pastoral Times*, Deniliquin), twenty years after the first domestic stock were introduced, it was recognised that the pastures of the great "saltbush province" which extended from Victoria to Queensland might deteriorate under heavy grazing, and "that it may be necessary to cultivate the saltbush itself (*Atriplex nummularia* Lindl.), or the pigsface plant (*Disphyma australis* (Sol.) N. E. Brown)".

Unfortunately very little has ever been done, and for many years unreliable pastures have covered the greater part of the 60 million acres of southern Australia in the 10-16 inch rainfall belt.

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Present Knowledge

The present knowledge of pasture communities in the semiarid environment of south western New South Wales, outside the areas where there is an arable phase, can be summarized as follows:

A. All pasture communities are degraded, and areas of climax vegetation are rare, or non-existent.

B. Annual production of forage is small, and warm season production is more common in the less degraded communities.

C. The shorter the vegetative period of the dominant in a degraded community, then the more violent the seasonal fluctuation in forage production, and consequently, in stock-carrying capacity.

D. Stock numbers at present are approximately 50 per cent. of the long term period 1870-1880, and well below the 1890-1899 peak.

E. Management of semiarid communities in stress periods is aimed at maintaining animals, not pasture plants.

F. Even in degraded pastures the animals utilise only a small fraction of total production.

G. Few experiments on either indigenous or exotic plant communities have given results upon which commercial recommendations can be based.

H. Insufficient investigations on indigenous species have been made, and often these have been limited to the dominants from degraded communities.

Since 1940, when the Imperial Bureau of Pastures and Forage Crops published a review of grassland investigations in Australia, there has been no advance in dryland agronomy comparable with the advances in other agronomic fields. So far none of the many species tried in experiments in the semiarid areas of southern Australia has proved successful, and it might appear that sparse perennial grasses (*Danthonia, Stipa* spp.) or dense ephemeral communities (*Hordeum leporinum* Link, *Erodium cygnorum* Nees, *Helipterum* spp.) as described by Moore (1940), are the best pasture communities that can be expected.

The initial premise in most dryland agronomy is that, pastures as they are at present, produce forage yields which are sub-optimal for the particular environment. After years of unrewarding investigations it appears that either this premise is not valid or the experimental procedures have not been adequate. One inescapable conclusion is that the native pastures are not improving.

In this review it is proposed to examine some important assumptions behind the selection of species, the experimental techniques for testing species and the establishment, production, and persistence of promising plants in degraded communities.

Selection of Species

Perennials or Annuals?

In semiarid pastures of the present day there is either an abundance, or a dearth, of edible forage. Both extremes may happen in the one year, and so the number of animals grazing on most properties is adjusted to survive the short drought without loss. These stress periods are related to the unreliable rainfall, and are most frequent from late summer through early winter.

In a favourable season, degraded grasslands of *Stipa falcata* Hughes, with annual herbage, growing on loam soils, may produce 2,000 pounds of oven dry forage per acre. On clay soils the degraded grasslands of *Danthonia caespitosa* Gaud., with scattered annual and perennial herbage, produce 1,500 pounds per acre.

With a similar rainfall and phosphatic fertilizer, an annual pasture of *Lolium rigidum* Gaud. (Wimmera ryegrass), and *Trifolium* or *Medicago* spp. has produced 4,000 pounds per acre.

Unfortunately, the forage yields from all these pastures are reduced to 200-300 pounds per acre when the seasons are dry, or the rains are poorly distributed. Most of this forage is produced by a few scattered perennial grasses and herbs which grow through autumn to spring, and are capable of limited growth in summer.

With such a large proportion of the total yield being contributed by winter-spring

annuals, it is not surprising that the summer rains are notoriously ineffective on most of the degraded grasslands in southern Riverina. For example, at Deniliquin in the January-May period of 1959, five inches of rain fell on the grasslands without producing any edible forage.

The presence of perennial species which convert this inefficient rainfall into forage appears to explain the differences in fluctuations in stocking rates (Figure 1), between the *Atriplex vesicaria* Hew. saltbush of the Hay district (mean annual rainfall 13.9 inches), and the grasslands of the adjoining Deniliquin

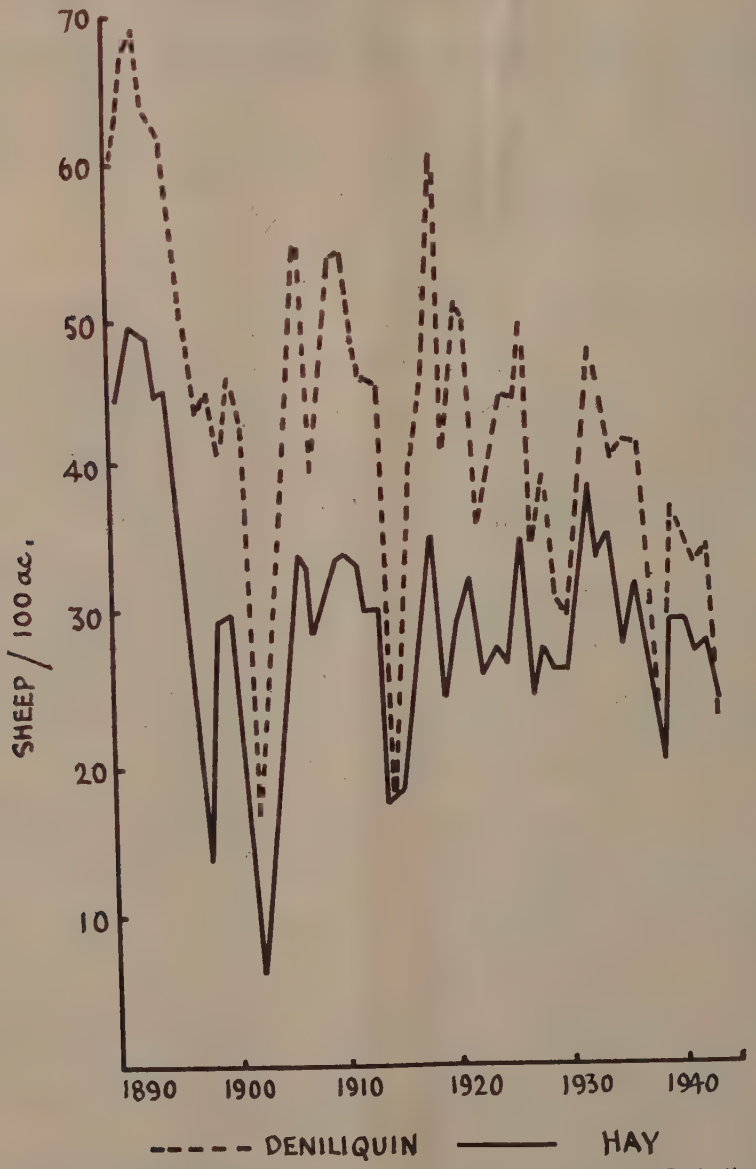

Figure 1—Annual stocking rates in Deniliquin and Hay Pastures Protection Board Districts, 1890-1943.

district (mean annual rainfall 16.0 inches). The smaller fluctuations in the sheep population in the drier Hay district can be attributed, in part, to the more stable summer production of *A. vesicaria.*

Up to 40 per cent. of the mean annual rainfall is of summer incidence in these two districts.

From a study of semiarid pastures in South Australia, Andrewartha (1943) has concluded that ". . . the presence in the pastures of edible drought resistant perennial shrubs prevents the big drop in carrying capacity during a short drought which is so characteristic of the pastures dominated by low annuals. Similarly during the good season the competition from the perennials tends to reduce the production of excess temporary feed by annuals. Thus the presence of edible perennial shrubs tends to 'iron out' the annual fluctuations in carrying capacity associated with annual fluctuations in rainfall."

Another reason for the emphasis given to perennial dominants in a semiarid environment, lies in the observation that a plant community dominated by annual species is not only unstable in forage production, and hence unpredictable in its carrying capacity, but is ecologically open to invasion by less desirable annual and perennial species. These invaders germinate and establish with the chance rains in the unreliable rainfall period when competition from the winter flora is at a minimum. An example of this process has been reported by Moore (1956) in his studies of *Heliotropium europaeum* L., and a similar invasion of annual grassland by *Tribulus terrestris* L. is taking place in the Deniliquin district at present.

Water erosion is not a problem in the Riverina Plain, but wind erosion occurs on sandy soils, or soils with a light textured A horizon overlying a clay subsoil. A grassland of perennial plants, even when it is dormant, helps to keep this top soil in place, whereas the dead remnants of annual plants blow away with the winds of early summer.

Finally, in terms of grazing use, perennial species can be grazed one to two weeks after rain, but the time lag with annual species is four to six weeks.

Exotics or Indigenes?

The usual and most economical practice has been to select exotic species for a particular environment from a homoclime. Underlying this matching technique is the assumption that all environmental factors are approximately equal, or can be simply and economically modified. This procedure tends to favour persistence of a species rather than its forage production. Invariably the range of environments over which an exotic species from a particular homoclime can be grown is far greater than its range as an indigene. This should be expected because homoclimatic studies are based on the measurement of the physical factors in the climate, and so cannot account for competition with the indigenous species and the differences in soils and in grazing animals between the environments. There is no substitute for extensive and intelligent field testing of exotics.

So far *Medicago sativa* L. (lucerne) has been the most successful perennial exotic, and it is possible that *Ehrharta calycina* Sm. (perennial veld grass) may be useful.

Donald (1941, p. 41) doubted if exotic species more efficient than the indigenous species would be found. He suggested that the genera *Danthonia, Panicum* and *Astrebla* might provide material for reseeding. Of course, the general assumption underlying these suggestions is that reseeded pastures will be managed in the same way as pastures of the present day.

Data on the regeneration of *Danthonia caespitosa* on clay soils at Deniliquin show that it grows too slowly, and the forage yields are too low, for the species to be of much value in a reseeding programme. It is now clear that this *D. caespitosa* grassland is a degraded community. The climax dominant was *Atriplex nummularia* Lindl.

A similar situation occurred on the permeable loams. *Stipa falcata* is the present dominant in a degraded grassland formerly dominated by *Danthonia caespitosa.* However, *D. caespitosa* replaced the original *Themeda australis* (R.Br.) Stapf., which was the dominant grass in the ground flora of the *Eucalyptus woollsiana Alliance.*

Both of these successional changes were described by Moore (1953), for the eastern Riverina, and the newspaper descriptions of southern and western Riverina pastures in the 1860-69 period, (*Pastoral Times,* Deniliquin) in conjunction with close inspection of relict areas, and root sampling in the clay subsoils, leave no doubt that there has been a complete change in the pastures.

It has been noted that the reseeding programmes in the Great Plains of the United States rely heavily on perennial grass components from the climax community, and on this basis it is suggested that rather than reseed with *Danthonia, Panicum,* and *Astrebla* spp., which are dominant in the degraded pastures of semiarid Australia, such species as *Atriplex nummularia, Themeda australis,* and *Dichanthium sericeum* (R. Br.) *A. Camus* might be used.

It is surprising how much contemporary data for early pasture communities are still available, and how little they are used. These can give a lead as to which species were the dominants in most of inland Ausralia. A comparison of the degraded pastures in southern Riverina with the original pastures suggests very strongly that it might be profitable to reintroduce the climax or near-climax species and synthesise a new range of communities. These re-introductions should be grown at low density, just as they were growing in the original pastures, and a new system of pasture management should be devised.

There seems to be no case for the use, or for the breeding, of any species from degraded communities until the climax dominants have been tested, and the appropriate management applied.

The destruction of perennial indigenes, and the dominance of exotics over large areas of inland Australia has posed interesting questions as to the size of the original populations of insects such as grasshoppers, or marsupials such as kangaroos.

Andrewartha (1943) suggested that dominance by an indigenous shrub (*Atriplex vesicara*), which is inedible for grasshoppers, would reduce the frequency and severity of grasshopper plagues in South Australia. This shrub has been destroyed by sheep over large areas, and has been replaced by annual exotics which are eaten by grasshoppers.

Norris (1950) has shown that for rangeland in New Mexico rodents and rabbits inhabit degraded communities in preference to near-pristine communities. Similarly, in southern Riverina, and possibly over much of semiarid New South Wales, the build-up of the small population of kangaroos recorded in the 1860-69 period, to their later plague proportions, may be a direct consequence of the favourable environment that developed when sheep increased the proportion of suitable grasses in the pasture communities.

Techniques for Testing Species

Exotic species are usually tested in nursery rows five links apart. Superphosphate has been the sole fertilizer in most cases. This technique was developed primarily for the arable areas of southern Australia. It favours legumes at the expense of the grasses, and favours grasses which produce well on soils that are deficient in nitrogen. In other words, no measure of the maximum expression of the species in the particular climate can be made if there is a soil deficiency other than phosphate. However, in recent years, most investigators have become aware of the necessity to supply adequate nutrients for each species.

Sward trials usually follow these initial row trials, and a set of typical experiments has been reported by Barley, Neal-Smith and Arndt (1958), for Deniliquin, and by Cuthbertson, Neal-Smith and Biddiscombe (1955), for Trangie. Swards are compounded from the successful grasses and an associated annual legume. This procedure has been devised in high rainfall areas to alleviate the nitrogen deficiency that exists in most Australian soils. Unfortunately, in a semiarid environment the competition offered by the annual legumes, or by weeds, is so great that few of the desirable perennial species are able to survive. The number of unsuccessful sward experiments is large. From an ecological viewpoint these failures are to be expected in low rainfall areas on nitrogen deficient soils to which phosphate fertilizers have been applied.

Although the sowing of annual legumes with perennial grasses has much to commend

it in high rainfall areas, the effects of competition in the first year appear too severe for such a scheme to be practised where the rainfall is scanty. In fact it is doubtful if perennial grasses and annual legumes could be grown together on a long term basis, since swards do not grow satisfactorily for more than a few weeks each year.

The successful establishment and persistence of so many perennial grasses, and of lucerne, in nursery rows throughout the low rainfall zones of southern Australia is in marked contrast to the failures in swards.

Establishment Procedures

The results from many reseeding projects in the range lands of the United States show beyond doubt that complete destruction of the existing vegetation is needed before sowing (see Hull *et al.* 1958).

At Hay, in the Southern Riverina, Muirhead (private communication) has shown that cultivation of the whole area is essential if vigorous plants of *Ehrharta calycina* are to be established on a soil which supports degraded *Stipa falcata* grassland.

Even in favourable seasons, numerous broadcast sowings of *E. calycina* and other perennial grasses into existing degraded grasslands of the southern Riverina have been complete failures. It can be concluded that the promiscuous scattering of seed of these valued perennial species into existing vegetation will benefit only birds and ants.

It may not always be possible to remove this unwanted vegetation by cultivation, even though adequate cultivation ensures a good seed bed and freedom from competition. In the United States, Robertson and Pearse (1945) have suggested that the opening of closed plant communities by drought, fire, or severe grazing might provide opportunities for successful reseeding.

In the southern Riverina, *Xanthium spinosum* L. (Bathurst Burr) and *Medicago* spp. spread rapidly after the 1865 drought (*Pastoral Times,* Deniliquin 1868), and *Hordeum leporinum* first appeared at Trangie following the 1902 drought (Clark 1948). However, there are no records of the deliberate use of drought in this way.

Fire could be useful, but it has been too difficult to control. Before settlement, and in the 1845-65 period, fires were common. Increasing sheep numbers and heavy grazing so reduced the amount of combustible material that fires could spread only in exceptional seasons. It is likely that the place of fire in maintaining the original plant communities has been greatly under-estimated.

Severe grazing for one season is limited in its effectiveness because there are many seeds of annual species already in the surface soil. Severe grazing over a number of years reduces the seed burden, but it is an erosion hazard on all except level clays.

Spraying with selective weedicide may be the only practical method of control when competitors germinate and establish after the seed has been sown.

A further technique of sowing into 'closed' communities might make use of vegetative propagation. This has been done successfully on an experimental scale at Deniliquin with a vigorous tetraploid strain of *Themeda australis,* with *Atriplex nummularia* and *Ehrharta calycina.*

In a semiarid area the eradication of competing plants remains the most important process. It is irrelevant whether these competitors are annual legumes, or are part of the existing vegetation.

Production and Persistence

In a semiarid area, soil water will be the ultimate limit in any attempt to produce a regular supply of forage in stress periods. This soil water can be conserved by a system of partial fallow using a plant species with the desired growth rhythm, either in sparse communities, or in widely spaced rows.

It is clear that a dense sward of either summer or winter species will out-yield these sparse populations when rainfall is well distributed and adequate. When rains are poorly distributed, these dense swards will produce less forage than the sparse populations. In a drought season the dense swards may die.

In south-eastern Queensland where the summer rainfall is plentiful but erratic, Paltridge (1955) concluded that lucerne was most productive when sown in 42 inch rows. The

space between rows was kept free from weeds. At Biloela, also in southern Queensland, Teakle (1954) has shown that swards of grasses were less productive than rows in a severe drought year. Furthermore the rows provided more grazing during stress periods.

In South Australia and northern Victoria, lucerne is broadcast at a sowing rate of one pound per acre. The resulting community is well spaced, and responds rapidly to summer showers. However, apart from heavy grazing in winter, little can be done to control the growth of annual weeds. Ultimately these weeds cause the stand to deteriorate.

To date lucerne is the only perennial pasture plant that can be treated in this way.

In the southern Riverina, summer and winter rainfall are erratic, and winter rainfall is effective only to the extent that it can maintain swards of introduced species such as *Hordeum leporinum* or *Erodium* spp. for a few weeks. The production and persistence of so many perennial grasses and lucerne in rows suggests that the row culture technique can be applied in this region.

Experiments are in progress to determine the most desirable spacing for rows, keeping in mind a reasonable level of production in favourable and unfavourable seasons, as well as the persistence of the stand during droughts.

Future Prospects

The major deficiency in the semiarid areas of southern Australia is experimental data. Uncritical extrapolation of applied techniques from high rainfall zones has been, and will continue to be, unprofitable. Rapid progress can be made in the future if semiarid communities are first studied in their own right, and specific techniques developed for them.

Some of the factors to be considered in future investigations can be summarized as follows:

A. The present pastures are extremely degraded, but even so, they produce adequate forage for present sheep numbers in favourable seasons. The introduction of perennial species with the ability to respond to rains in any season, will tend to stabilize the animal populations by bridging the stress periods when annual species fail. At present there is no point in introducing more annual species to further increase yields in favourable seasons.

A plant community with a large proportion of perennial species in it will be more resistant to invasion by weeds than a community of annual plants can be. There is no reason why these perennial species should be grasses or herbs, and not large shrubs or trees. Ideally they should be nutritious and not too palatable.

B. Perennial indigenes from the near-pristine communities should be investigated before much attention is given to the present dominant species from degraded communities.

The outlook for perennial exotics is not good. Lucerne and *Ehrharta calycina* may be useful, but unlike the species in degraded pastures they will require sympathetic management.

C. Eradication of competitors is necessary for successful routine sowings in a semiarid area. Seeding in spring when rain falls may offer the best chance of successful establishment, particularly where a short winter fallow can be arranged. This applies particularly to the winter rainfall zone where the summer flora is usually weak.

The sowing of a perennial grass with an efficient competitor in the shape of an annual legume partly or wholly negatives the care expended in preparing an open community for seeding. It is possible that a balance may be struck between competition from legumes and nitrogen gain, by using nitrogen fertilizer at seeding, or by sowing pure grass, and oversowing the annual legume in the second year.

D. In semiarid areas, improved cultural techniques appear as necessary as the introduction of further botanical material, and row-pasture, adequately fertilized, appears to be a promising technique for producing consistent yields of green forage in unfavourable periods. Experiment will show whether rainfall in a given environment can profitably support a specific perennial grass and an annual legume, or whether nitrogen fertilizer should be applied to pure grass. Alternatively, the deficiency of nitrogen in the soils may be avoided by using pure stands of lucerne.

In the final analysis, all of these techniques will lead to the development of a semiarid pasture which has a selected density of chosen species operating on adequate nutrients.

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DEPARTMENT OF AGRICULTURE, SOUTH AUSTRALIA

Applications for the position set out hereunder will be received by the Public Service Commissioner, 31 Flinders Street, Adelaide, until and including Friday, 14th October, 1960.

Applicants should state full names, address, date of birth, marital status, academic qualifications, practical experience, and give particulars of war service (if any). Copies only of testimonials should be submitted with the application.

The appointee may be required to contribute to the Government Superannuation Fund.

Agriculture Department.

DAIRY RESEARCH OFFICER (Temporary)

Salary: Commencing salary will be fixed according to qualifications and experience. Although a permanent appointment will not be made at this stage, the appointee will qualify for the annual increments of salary up to a maximum of £1,920 per annum if a Graduate.

Duties: Carry out basic studies on grazing habits, health and management practices in relation to production to provide information for further investigation and extension.

Qualifications: Applicants should have a degree in Agricultural or Veterinary Science. Experience in dairy herd management will be an advantage.

EXTENSION AS A PROCESS

P. C. ANGOVE

Extension is a term that defies definition. It is one of those terms that has come into our language and that we have come to understand as meaning the conveying or presentation of agricultural knowledge from the research worker to the farmer.

"Extension officer" is even more difficult to define. It can mean anything from a pure administrator to an applied research worker who occasionally talks to farmers. Here again, we should not disagree over terminology but rather accept that an extension officer is one whose main job is that of bringing agricultural information to farmers.

History

Rural production has increased in South Australia very greatly during the past 60 years, and of course, particularly in the past 30 years as the figures in Table 1 show.

The period of 30 years and 60 years has been chosen because it is approximately 30 years since the first agricultural advisers were appointed to the Department of Agriculture.

The figures show that wheat yields increased by about 50 per cent. during the first 30 years and by approximately 150 per cent. during the second 30 years. Sheep numbers rose by 50 per cent. during the first 30 years and by 100 per cent. in the second 30 years. Cattle numbers increased in the same proportion, that is, 50 per cent. in the first 30 years and about 100 per cent. in the second 30 years.

There can be no doubt that much of this increase has been due to the opening up of new land, but this development has only been possible through the activities of research workers and agricultural extension officers working together.

The Process

Reasons underlying these increases in production are interwoven. New land could not have been opened without research and development. Some thirty years ago the first trace element deficiency was discovered on

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TABLE 1

South Australian rural production 1900-1957.

	1900-1	1927-8	1956-7
Wheat acres	1.9 million	2.9 million	1.4 million
„ bushels	11.3 million	24.0 million	31.4 million
„ av. yield/acre	5.9 bush./acre	8.2 bush./acre	21.8 bush./acre
Sheep numbers	5.2 million	7.5 million	15.0 million
Cattle numbers	215,000	316,000	622,000

Lower Yorke Peninsula. The use of manganese in those districts has made a large area of country available for development. On the Coonalpyn Downs and on Kangaroo Island we have very recent examples of the benefits of trace elements, superphosphate, and various strains of legume. In the cereal areas, subterranean clover and other legumes are now playing a major part in maintaining soil fertility.

To effect this development we have three types of scientific worker.

The Fundamental Researcher

He seeks new knowledge for the purpose of adding to our existing knowledge. He has little concern whether the new knowledge is capable of being immediately applied for the benefit of the farmer. Basically he seeks knowledge for the sake of knowledge.

The Applied Researcher

He seeks answers to specific current farm problems. We have workers in many fields, including the Waite Agricultural Research Institute, the Department of Agriculture, Roseworthy College, and so on. These workers conduct specific fertilizer trials, variety trials, weed spraying trials, insecticidal trials and so forth with the prime aim of getting an answer to a specific problem. They are the workers who provide the immediate answers for the extension worker to take to the farmer.

Extension Officer

He is the key to the whole process. He takes knowledge from the researcher and presents it to the farmer — but he has more to do than simply make this information available.

The research officer can do this and, indeed, he often does so. The extension officer, however, has to present his ideas in such a way that the practice will be adopted and become a recognised farm-practice. This is a highly skilled job.

We have seen many examples of research workers expounding theories to farmer groups without knowing the farmer's background and the way he thinks. This has often led to a rejection of the practice even though the practice was in itself sound. It has also on occasion led to the adoption of a practice which was either unsound or uneconomic for a particular farm or district.

Information

The main point of this discussion has so far been that scientific agricultural information is all important. To the research worker, and indeed to the scientist in general, accuracy of information is vital. We see countless examples of this, particularly in our scientific literature.

The difficulty is that the pure scientist does not see his information in the same light as an average farmer. This is because they have not the same outlook on life.

We get most of our information about our world in a variety of ways. Most of it comes to us through our senses. Much comes from other people, either orally or in writing. We can call this, quite simply, factual information.

This is our most reliable information and is most useful in our daily communication. It is what we might call public, because it is information we can easily share with others.

Some of our information comes from sources we cannot accurately describe such as insight or intuition. These forms of information are also important because they influence our lives and actions. This latter information may be called private because it cannot easily be shared with others, for example, religion, art and emotional life.

It is a combination of private and public information that influences the outlook and actions of the scientist and, perhaps in a totally different way, his listener.

In putting forward our ideas we must vary our terms of reference according to our audience. To a group of biologists we could refer to a whale as a warm blooded mammal while to a group of fishermen it would be a fish. Neither definition is accurate, but each is useful for a particular purpose.

P.I.M.

Extension work has been defined as a process which involves people, information, and method. Successful communication requires the satisfactory integration of these three.

It is argued that information on agricultural facts is not a problem though some argue that

it is. Firstly, extension officers are often unable to secure specific answers to problems and it is known from personal experience how difficult it is to obtain even one new story to take to an important agricultural occasion.

Despite these difficulties, however, the extension officer is in possession of a wealth of information which may be known by farmers, but is not yet in general practice. As general practice is the ultimate objective of the extension worker, he cannot argue that he is out of work.

Method can and must be varied according to circumstances but we will deal with that later.

People

People are the crux of the problem of successful communication — and of these we know all too little. The Department of Social Studies at the University of Adelaide is doing a little — but all too little — to provide us with some basic facts about South Australian rural people. They have now agreed that the term community is far too wide to be of any real value in determining the likely reactions of individuals. The term must be narrowed to groups within a community and if necessary, to units even smaller than this.

The Barossa Valley is held up as an example of a thriving community; and we see many slogans about the wealth of the Barossa Valley, the Community Hotel and so on. In actual fact the Barossa Valley, in even broad terms, is made up of a series of three or four towns which are intensely town conscious. It is made up, too, of two or three religious denominations, each very intense in their outlook. These groups do not mix to any great extent.

In a study in Gippsland, Victoria, Emery and Oeser found four variables that influence the adoption by farmers of a new process. These were resources, skills, interests and social motives. In other words:—Is a farmer capable, and has he the necessary equipment, to put a recommendation into practice? Has he the necessary skill to work out a particular chemical formulation or has he ever performed a Mules operation on his own in the past? Is he interested in growing more produce — does income tax loom large? Will the practice be acceptable socially?

These variables are found to complicate the simple relations about the amount of exposure to new ideas and the degree of advanced practices.

Survey in South Australia Area

In South Australia we have recently made a study of a group of farmers from one of our rural districts. Some details of the results are given below.

84 farmers — mixed group included 48 agricultural bureau members + 1 doubtful.

78 indicated they belonged to one organisation or another.

Growers Co-operative — 65 members, 24 attend regularly; 37 per cent.

R.S.L. — 55 members, 6 attend regularly; 11 per cent.

Bureau — 48 members, 13 attend regularly; 27 per cent.

Why did you join this organisation? — They join for a variety of reasons, most popular of which is protection of their interests. However, 44, i.e., 56 per cent., join to improve their agricultural knowledge.

Educational Background — some resentment of question — 61 answers.

27 left school at 14 years at Grade 7 or lower = 44 per cent.

8 left school at Intermediate or higher = 13 per cent.

This type of information sets extension officers thinking about how to present their stories.

Physics and chemistry are closed books; and even elementary mathematics with the extension officer's series of charts and graphs are largely not understood.

What is required is a series of recipes which will work and an opportunity for the farmer to see them working.

When asked, where do they get their new information, we get a surprising answer — 59 replies in all.

25 out of 59 from Press and Radio

20 from neighbours and Department of Agriculture officers

14 from all other sources.

What do they read most regularly?

56 out of 59 the Local Paper.

Only 37 out of 59 read the *Journal of Agriculture*.

Only 9 read the *Advertiser* (Adelaide daily paper).

Yet the *Advertiser* is considered the peak of achievement for a news story.

When asked how they broaden their practical experience, we received 67 answers.

From the way the question was framed it was not possible to sort out which they considered most valuable.

The greatest number, 56, said visits to neighbours' properties were valuable.

38 said Bureau Field Days were valuable, but there is obviously some duplication.

Only 14 said meetings were valuable.

During a visit to South Australia this year, Professor Wilkenning posed the theory that farmers will adopt a new idea for two prime purposes only — money and time. He presented the scheme shown in Table 2.

The process is complicated, and arrows can be drawn in many directions. The whole purpose of presenting these thoughts is to show that we can never know too much about the people to whom we communicate ideas if we want those ideas to be understood as we understand them — and still more importantly — if we want action along the right lines.

Numbers of Extension Officers

There is a perpetual cry that there are not enough extension officers. In support of this, there is no doubt that extension officer to farmer contact is highly successful in the rapid adoption of new ideas.

In South Australia our country extension officers vary in the number of farmers they advise from 350 to approximately 5,000. While there are many difficulties for these men, no one can argue that the South Australian system of agricultural extension is not successful from the point of view that new practices are comparatively rapidly adopted. This may be due in part to our Agricultural Bureau system.

The myth that adoption requires constant contact between the farmer and the agricultural officer is simply not true, as the figures in Table 1 show. Much evidence points to farmers seeking advice and confirmation of new ideas from fellow farmer innovators. There is a hierarchy amongst farmers which is not based on social standing (such as being a member of the District Council) but rather on skill and competence alone.

It is to these innovators that extension officers should direct their energies, if they wish to achieve maximum change in a district as quickly as possible.

TABLE 2

Goals and motives of farmers.

Ultimate Goals	Biological Needs	Comfort	Recreation	Mental Health	Prestige	Social Integration
Intermediate Goals		Money			Time	
Production Goals	Timing of Operations ↑	Speed of Operations ↑	Soil Conservation ↑	Land Ownership ↑	Maintenance of Plant, etc. ↑	
	Techniques of Farming					

These innovators will seek ideas not only from the extension officer but also from many outside sources, such as posters, the written word, industrial agents and so on. These are the men who ultimately determine whether or not a new practice will be generally adopted in a district.

Private Agricultural Consultants

The cry for more extension officers is common among farmers as well as among scientists; but the answer undoubtedly lies in the establishment of farm clubs or a private farmers' consultative service. In the farm club, a group of 50 to 60 farmers combine together to employ their own adviser for a cost of £50 to £60 each per year. Agricultural economics figure largely in the activities of the club, but dangers lie in using the adviser for purposes other than advising.

In South Australia there has not been a glimmer of interest in such a scheme. The farmer's standard reply is, "Why should I pay for two advisers, one by taxes and the other by myself?"

The answer to this is that if you want anything personally you must pay for it, no matter what it may be. In a hotel you may use the bathroom free of charge, but if you want a private bath, this will involve an extra charge. Similarly, on an overseas trip, the more exclusive the cabin, the greater will be the charge.

An alternative to the farm club or a government advisory service is a farm consultative service where for a fee, farmers may seek specific advice. Advice would range from agronomic questions to animal husbandry and the overall economic operation of the farm. Such a scheme inevitably involves several officers with extension training in special lines. The advice would doubtless be good, but it does involve the farmer in a charge.

Here again, apart from some sheep advisers, there is no such service in this state. But it is the type of thing that we as Institute members could and should encourage, provided the right men are offering.

While unknown at present in the South Australian agricultural scene, such schemes will doubtless be well known within ten years. The Institute should do all it can to foster such schemes. For the protection of farmers, it could certify the worth of various private practitioners and it should advise practitioners in which areas it believed such a scheme would work.

Such schemes would enormously strengthen South Australian agriculture. They would do nothing to undermine the Department, because private practitioners would need to be serviced in the same way as farmers are serviced at present.

The whole purpose of a government employed extension officer is that he has an obligation to persuade a farmer to change his practices for the benefit of the taxpayer as a whole, rather than for the benefit of the individual farmer himself; although the farmer himself will, of course, benefit from the change.

To do this effectively a study of the farmer's likes and dislikes and his rock-anchored values is essential. The extension officer must then find ways and means of getting past these hurdles.

The private consultant on the other hand places the farmer in the position of a seeker after information — and by this time the job of adopting a new practice is already half done. In addition, a private consultant has no obligation to see that the farmer actually follows his advice.

Decision Making

Why do farmers make these changes? How do they make decisions?

People will not change their behaviour if—

(a) the community strongly disapproves,
(b) their friends mildly disapprove, and
(c) unless they see the change as advantageous to themselves and/or their friends.

Natural reaction to all change is at first resistant. Farmers as a whole first learn what is required, judge its worth for themselves, test their decision on their friends and then accept or reject the decision. This means that the extension officer, before he starts, must learn the forces favouring a change and the forces opposing change. Until he can reduce the opposing forces and increase the favourable forces he has no hope of success.

This brings us right back to Wilkenning's theory that people do things primarily for time and money, and the difficulty the extension officer experiences in getting information about people unless he seeks it for himself.

Methods

I do not propose to talk at length about various extension methods. There is a wealth of extension methods available. Each has a specific place and a specific purpose.

Here again, the methods can be divided into those that gain attention for a new process, develop interest in that process, create desire for the process, secure action and ensure continued action.

The poster, the newspaper story and the radio all gain attention and develop interest in a particular process, but, we believe, do little more. The survey, of course, that we have discussed earlier, may prove our preconceived ideas to be quite wrong.

Various methods overlap the different phases of the extension process. Without discussing the matter at length it is enough to say that the poster is never likely to gain action and that the farm visit is wasteful of time and money except for clearing queries about a process which is already reasonably well understood and under way.

This statement on farm visiting is debated hotly, because farm visiting is a pleasant occupation. But I am emphatic that no extension officer can justify a farm visit except for a specific purpose — and that purpose should never be the popularising of a new idea.

Graduates in Extension

From the Institute point of view it is tragedy that there are, outside the administration, with three or four exceptions, no graduates in the practical extension field in South Australia. This position prevails despite the fact that in the Department of Agriculture we offer a graduate a clear £100 a year more than the non-graduate for similar duties in the extension field.

I have no intention of blaming the University for this, though I feel the University could with some advantage teach the basis of Rural Sociology in its undergraduate course. The position is, I believe, a carry-over from the days of not so long ago when the research officer was paid more than the extension officer; and so it was natural that the young graduate should enter research.

The position today, however, is that both the salaries and opportunities for workers in extension and research fields in the State Department are similar. There is no reason, therefore, why a trained extension officer should not rise to the highest position within the Department.

What is required now is that the prospective graduate should be presented with the "facts of a life" in extension work. This, of course, can be done in an impartial way by our new graduand sub-committee.

Let me assure you, from probably a biased point of view, that it is an exciting life. It is a life full of situations of jobs well done. There is great satisfaction in seeing another man achieve something which you advised him to do. The job of an extension worker is probably even more highly skilled than that of a research worker, who, of necessity, works in a restricted field.

Let me assure you that money alone is not the sole criterion of life. Even if it were, the money and the opportunities in government service are just as great in extension as in research; though I admit that government does not, and in my opinion never will, compete with the University or C.S.I.R.O. for salary ranges.

The important things in life are the personal satisfactions that are achieved in any field of work. In this regard, agricultural extension work can be very rewarding indeed.

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Technical Notes

Losses of Nitrogen on Burning Native Pasture at Katherine, N.T.

Much of the native pasture in the Katherine region is burned annually during the dry season, either by accident or design. As part of a general study of the nitrogen cycle of natural vegetation in the region, a preliminary examination was made in 1959 of nitrogen losses to the atmosphere on burning native pasture.

The pasture studied was composed largely of *Sorghum plumosum, Themeda australis,* and *Chrysopogon fallax*. Experimental difficulties were anticipated if the pasture was burned *in situ,* so samples were cut and then burned under controlled conditions. Burning was carried out on a metal tray, 38 x 38 in., over which was fitted a bottomless fly-wire cage 36 x 36 x 36 in., permitting completely aerobic combustion yet retaining airborne fragments of ash.

Tests were made on four occasions between April and August. At each date, six pasture samples, approximately 1000 g each, were cut and allowed to air-dry for 1-2 days. A 100 g subsample was taken from each for nitrogen and dry-matter determination. The samples were burned, the residues collected and weighed, and from each a subsample was taken for nitrogen determination.

Results are shown in Table 1. After burning, 14 per cent. of the dry matter was retained in the residue. The grass before burning averaged 0.37 per cent. N, a typical figure for Katherine pasture in the dry season. Nitrogen content of the residue after burning averaged only 0.17 per cent. N. (A rather high figure was recorded at the last burn, when the samples contained an abnormally large proportion of thick-stemmed material that was incompletely consumed). The average loss of nitrogen to the atmosphere on burning was 93.5 per cent.

The average dry matter yield of Katherine native pasture at maturity is 1200 lb per acre, giving a nitrogen yield of 4-5 lb per acre. The loss of nitrogen to the atmosphere on burning would thus amount to a little over 4 lb per acre. The return of nitrogen from rainwater annually is not greater than 2 lb per acre (Wetselaar, unpublished data). On the other hand, Tchan (unpublished data) reports the presence of non-symbiotic nitrogen-fixing organisms in the surface soil at Katherine, and leguminous species are present, though infrequent, in both the ground and

TABLE 1

Nitrogen and dry-matter losses on burning native pasture.

Date	Percentage loss of dry matter on burning	Percentage N in grass before burning	Percentage N in residue after burning	Percentage loss of N on burning
April 24	87.7	0.41	0.18	94.2
June 3	83.4	0.29	0.11	93.8
July 6	86.3	0.46	0.13	96.2
August 10	87.1	0.33	0.26	89.7
Mean	86.1	0.37	0.17	93.5
S.E. ±	0.95	0.038	0.033	1.36

shrub layers of the native vegetation. It is quite possible that the combined annual increment of fixed nitrogen could reach a figure of 2 lb/acre nitrogen. It is therefore concluded that frequent burning is not likely to constitute a severe drain on the total nitrogen reserves of the soil, which are of the order 3000 lb/acre N within the root zone of the ground flora.

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Cobalt Status of the Wallum

Introduction

The lateritic podzolic and low humic gley soils of the Wallum region of south-eastern Queensland have been reported by Andrew and Bryan (1955 and 1958) as deficient in phosphorus, nitrogen, calcium, potash, sulphur, copper, zinc, molybdenum and boron. This places these soils among the poorest in plant nutrients to be recorded. The authors therefore anticipated that cobalt might also be in deficiency. In some of the pasture species grown on the Wallum country Beck (personal communication) had found cobalt values at or below the minimum for animal health. On the other hand, on improved pastures grown on these soils sheep have been maintained in good health for 3 years, and beef cattle for over one year without clinical manifestations of cobalt deficiency.

Analyses of plant materials, fertilizers and soils were therefore made to determine their cobalt status.

Materials and Methods

All plant and soil samples were obtained from the C.S.I.R.O. experimental area at Beerwah, S.E. Queensland. Fertilizer samples were taken from commercial stocks on hand.

The species selected were *Trifolium repens* L., collected in September 1957, and *Paspalum commersonii* Lam.C.P.I. 2696 and *Desmodium uncinatum* (Jacq.) D.C. C.P.I. 8990 collected in February 1958. The samples were from well established stands several years old, and were selected at the stage of growth just before flowering. Where possible, stands on both a lateritic podzolic and a low humic gley soil were sampled. The samples were plucked by hand, care being taken to ensure a minimum of soil contamination.

Soil samples were collected by digging up a shovelful of soil from the 0.4 in. horizon and taking material by hand from the uncontaminated surface. One composite sample was taken from the site where plant samples were collected and another from a virgin soil site within 100 links of the former and on the same contour. In each case six to eight samples were taken which were then bulked, mixed and sub-sampled for analysis.

Plant samples were ground in a Wiley mill to pass through a 1 mm stainless steel sieve, 10 g samples were digested, and cobalt estimated according to the method of Marston and Dewey (1940) (tri-acid digest) as described by Piper (1947).

This method required some modifications for soils, the iron content of these being much greater than that of plant samples.

After removal of the iron by the method of Grahame and Seaborg (1938), the hydrochloric acid extracts were evaporated to dryness, the copper removed by extraction with

dithizone and the cobalt estimated as the nitroso-R-complex (Piper 1947). This method gives the cobalt extractable with concentrated hydrochloric acid after ignition at 550°C.

Fertilizers were analysed spectrographically. The samples were of superphosphate marketed in Queensland and of a sowing mixture consisting of 5 cwt basic superphosphate, 5 cwt calcium carbonate, 1 cwt potassium chloride, 7 lb copper sulphate, 7 lb zinc sulphate, 4 oz sodium molybdate and 7 lb sodium borate.

Results

The cobalt concentrations in plant and soil materials are shown in Table 1.

Oertel and Giles (1959) recorded < 2 p.p.m. total cobalt for a virgin Wallum lateritic podzolic soil. They used an optical spectrographic method involving complete volatilization of the sample. The present values (0.03 to 0.05 p.p.m.) do not conflict with their findings.

Cobalt was not detectable in either of the fertilizers when arced in their original form. The use of 8-hydroxyquinoline concentrated the cobalt in the superphosphate fivefold and in the mixture fifteenfold. Cobalt was still not detectable. David (personal communication) stated that the concentration of cobalt must be < 5 p.p.m. in the superphosphate and < 2 p.p.m. in the mixture.

Discussion

In most areas of cobalt deficiency, values for "healthy" soils are generally much higher than those shown in the present series, while values for "sick" soils are seldom as low; e.g. in Florida "sick" soils ranged from 0.001 to 0.016 p.p.m., and "healthy" soils from 0.2 to 1.3 p.p.m. (Becker, Erwin and Henderson 1946), while cobalt deficient soils at Denmark, W. Australia, had a mean value of 0.6 p.p.m. (Underwood and Harvey 1938), although some of them were < 0.03 p.p.m. (Harvey 1937).

It is generally agreed (Stewart 1949) that a cobalt concentration of 0.07 to 0.10 p.p.m. in the dry matter of feed is adequate for normal growth and health of sheep and cattle. By this standard the cobalt value for *T. repens* is higher than required, the values for *P. commersonii* are adequate and those for *D. uncinatum* are marginal. In general the values on the lateritic podzolic soil are marginal, though on neither soil are the values much above adequacy.

In view of the low cobalt values obtained, six of twelve 6-tooth crossbred wethers which had been grazed continuously on these pastures for two years were given cobalt bullets

TABLE 1

Cobalt concentrations of pasture species (tri-acid soluble Co) an soils (HCl soluble Co) (on dry weight basis).

	Lateritic podzolic soil p.p.m.	Low humic gley soil p.p.m.
Species		
Desmodium uncinatum	0.06 ± 0.02	0.09 ± 0.03
Trifolium repens	—	0.19 ± 0.06
Paspalum commersonii	0.09 ± 0.02	0.11 ± 0.02
Soil 0.4 in.:		
Under Pasture	0.05 ± 0.05	0.09 ± 0.05
Virgin	0.03 ± 0.017	0.10 ± 0.027

in December 1958. A comparable group of six sheep was untreated. By December 1959 no differences were found in appearance or in weight changes, all sheep being healthy.

Maximum pasture yields at Beerwah have been approximately five tons of dry matter per acre per year. Assuming a cobalt concentration of 0.10 p.p.m. such pasture contains approximately 0.5 g of cobalt. This cobalt may come from fertilizer or soil.

The cobalt content of the fertilizer sowing mixture is $<$ 1.1 g per acre, while that of the additional annual application of 2 cwt/acre of superphosphate is $<$ 0.05 g cobalt. Thus over a five year period the total cobalt added in fertilizers is $<$ 3.1 g per acre, a very small amount.

Soil cobalt values are low, but represent much greater total amounts of cobalt than those added in fertilizer. The lateritic podzolic soil contains approximately 6 g cobalt per acre inch, and the low humic gley soil approximately 15 g cobalt per acre inch. These results confirm the finding of Kidson (1937) that the cobalt status of soil is not a good guide to the need for cobalt supplements for stock.

As Whyte (1957) has shown that the cobalt content of pasture species in India is intermediate at the pre-flowering stage between the concentrations when young and at flowering, it seems reasonable to regard our values as representative of the species under these conditions.

In view of the differences in the cobalt values among plant species, it might be possible for animals grazing certain types of pasture on these soils to become cobalt deficient while on other types of pasture they might remain healthy.

The present evidence is that cobalt supplements are not needed on these soils but in view of the closeness to minimal values, the possibility of cobalt deficiencies arising in later years or on other variants of these soils should not be overlooked.

Acknowledgments

We are indebted to Mr. D. J. David of the C.S.I.R.O. Division of Plant Industry, Canberra, for spectrographic examination of fertilizer samples, and to Mr. A. B. Beck of the C.S.I.R.O. Division of Animal Health and Production, Perth, for analysis of some plant samples.

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Dry Matter and Protein Yields in Four Strains of *Leucaena glauca* Benth.

Recently, Hutton and Gray (1959) discussed the problems involved in adapting *Leucaena glauca* as a forage for the Australian tropics. This work did not include an investigation of the dry matter and protein yields of the different strains of *L. glauca* described.

In Hawaii in a locality with a 50 to 60 inch rainfall, Takahashi and Ripperton (1949) produced over a three-year period a mean annual yield of 8 to 9 tons of dry matter per acre containing 2,442 to 3,146 lb of protein. All plots were cut two to three inches above ground level with a motor scythe and the treatments included three, four and six harvests per year. Anslow (1957) reported on the yields he obtained with *L. glauca* in Mauritius where the annual rainfall was 61.5 inches. Here three harvests in the year were made, the plots being cut mechanically four inches above ground level with an autoscythe or tractor and cutter bar. A yield of 2.8 tons of dry matter per acre containing 1,696 lb of protein was obtained over the 12 months.

The work reported in Hawaii and Mauritius was done with the Hawaiian type of *L. glauca* using a harvesting technique similar to that accorded lucerne. During the 1958-59 season at the C.S.I.R.O. Pasture Research Station, Samford near Brisbane, the comparative dry matter and protein yields of the Peru (C.P.I. 18614), El Salvador (C.P.I. 18623), Guatemala (C.P.I. 18228), and Hawaii (C.P.I. 18624), strains of *L. glauca* were measured in a half acre trial established four years previously and which had been rotationally grazed by cattle for three years. The trial, which was planted at a density of 2,778 trees to the acre, had never been irrigated, and had been fertilized once only at planting with 4 cwt of superphosphate and 1 cwt of potassium sulphate per acre. The trees had a stabilized framework and had been kept to a height of 4 feet 6 inches by grazing and cutting back when necessary.

Early in September 1958 all the trees were completely grazed by cattle. Five trees of each of the strains were selected at random, and on November 26, 1958, January 13, 1959, March 18, 1959, and June 6, 1959 all the leaves as well as stems ¼ in. or less in diameter were removed. Immediately after each sampling, all the trial was grazed and it was observed that the difference between the material removed in sampling and that removed from the other trees by grazing was negligible.

The percentages by weight of leaf in the dried samples for all strains was 77 per cent. at the first harvest, 68 per cent. at the third harvest, and 84 per cent. at the fourth harvest, and there were no significant differences between strains in this regard. Percentage of leaf was not obtained for the second harvest. When the trees were growing vigorously over the January to March period, there was a tendency for the forage to contain a higher proportion of soft young stems. The total yields of forage and protein are given in the table.

The rainfall at Samford during the sampling period from the beginning of September, 1958 to the end of May, 1959 was 40 inches and that for the year ending September, 1959 was 47 inches. Under these conditions, the Peru strain treated as a grazed tree gave protein yields comparable with those obtained from the Hawaiian strain in a better rainfall by Takahashi and Ripperton (1949) who harvested the ungrazed plants by periodically cutting them to ground level. These workers however, recorded almost twice the dry matter obtained with the Peru strain at Samford. Nevertheless the dry matter and protein production of the Peru strain at Samford is better than that of good areas of irrigated lucerne producing 6 to 7 tons of dry matter and 2,400 to 2,800 lb of protein per acre per annum as shown by Teakle (1957). It also compares favourably with high quality clover-rye grass pastures in New Zealand producing annually 11,000 to 15,000 lb of dry matter and over 3,750 lb of protein per acre (Sears 1953, Melville and Sears, 1953).

TABLE 1

Forage and protein yields from four strains of L. glauca.

Strain	1st Harvest	2nd Harvest	3rd Harvest	4th Harvest	Total
Peru (C.P.I. 18614)*					
Mean dry matter yield (lb/acre)	3863	3362	2241	1730	11236
Mean protein yield (lb/acre)	977	1118	783	339	3217
Mean protein percentage	25.6	33.3	35.1	20.2	28.6
El Salvador (C.P.I. 18623)					
Mean dry matter yield (lb/acre)	1585	1719	1173	1368	5845
Mean protein yield (lb/acre)	433	573	414	290	1710
Mean protein percentage	27.2	33.3	35.8	21.3	29.2
Guatemela (C.P.I. 18228)					
Mean dry matter yield (lb/acre)	1229	1473	1061	902	4865
Mean protein yield (lb/acre)	314	468	356	183	1321
Mean protein percentage	25.6	27.5	33.1	20.4	27.1
Hawaii (C.P.I. 18624)					
Mean dry matter yield (lb/acre)	285	267	470	313	1335
Mean protein yield (lb/acre)	79	88	161	77	405
Mean protein percentage	27.5	32.9	34.3	24.7	30.3

At $P < .05$ dry matter and protein yields of Peru are significantly greater than El Salvador, Guatemala and Hawaii. No significant differences between El Salvador and Guatemala both of which were significantly greater than Hawaii.
*C.P.I. Commonwealth Plant Introduction Numbers.

The Peru strain of *L. glauca* was significantly the most efficient in the production of dry matter and protein at Samford. The protein content of the forage of all strains of *L. glauca* was maintained at a high level particularly at the second and third harvests when the trees were growing vigorously. Protein level was lowest at the June harvest when growth was slow. A major aim of the breeding and genetical work with *L. glauca* at the C.S.I.R.O. Division of Tropical Pastures is to retain in hybrids the high dry matter and protein yields of the Peru strain but eliminate its poor seeding ability and high frost susceptibility.

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A Vascular Necrosis of Tomato Roots

In the winter and early spring of 1947 serious losses of tomato plants occurred in unheated glasshouses in the Mona Vale-Warriewood suburbs of Sydney. Plants, which were apparently healthy as far as above ground symptoms were concerned, collapsed and died within a few days as the result of an advanced rotting of the roots. Growers reported that losses due to this disease had been experienced for many years. They have named the disease drop head wilt.

Since 1947 the disease has been present in the district each year. Occasionally all the plants in individual glasshouses are lost but usually, if the disease is present, it attacks from five to fifty per cent of the crop. The great majority of houses are free from the disease and annual district losses are probably one to two per cent. A house which contains plants affected with drop head wilt one season may be free of the disease during the following season.

Symptoms

Until wilting occurs (Figure 1) there are almost always no obvious symptoms on the leaves or stems; but occasionally a mild mosiac of dark and light green may develop in the leaves. The root necrosis is of characteristic pattern, making field diagnosis reliable. In the early stages of the disease a macroscopic examination of a cross section of the tap root reveals a thin brown necrotic ring in the region of the outer vascular system and the pericycle. Tissues inside the necrotic ring are still apparently healthy and so is the cortex and epidermis. Later the necrosis involves the whole of the stele (Figure 2). Although the cortex may ultimately become discoloured this breakdown may be due to other causes and is not consistently associated with the other symptoms. Secondary roots exhibit the same symptoms as the tap root and the necrotic ring is clearly visible when they are shaved from the tap root. There is an early total collapse of rootlets. Necrotic symptoms are always restricted to the root system and cross sections of any portion of the stem give no indication of the presence of the disease.

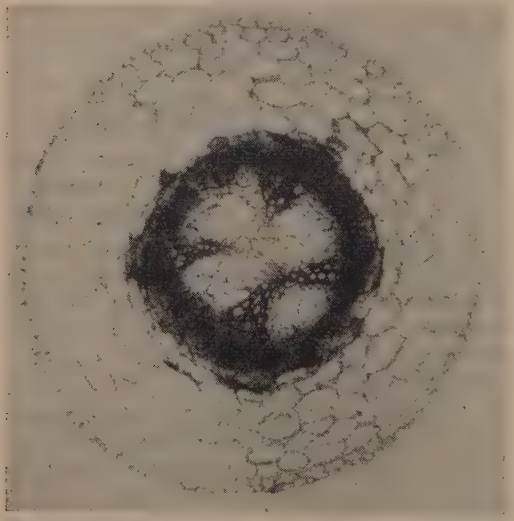

Figure 1—Transverse Section of tomato root showing distribution of necrotic tissue caused by the Tomato Root Necrosis Virus.

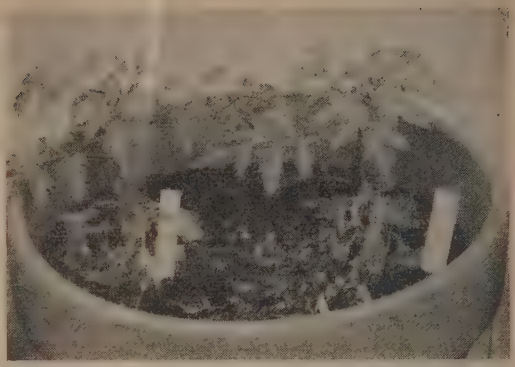

Figure 2—Wilted tomato plants twenty-one days after mechanical inoculation with tomato root necrosis virus. The two plants at the back are uninoculated controls.

Causal Agent

The casual agent is a virus which is readily sap transmissible and rapidly becomes systemic in tomato without the formation of local lesions. It was purified by a series of propagations from single isolated necrotic lesions on tobacco and the absence of systemic mottle in several hundred tobacco seedlings inoculated over a period of some three years indicates

its freedom from contamination with tobacco mosaic virus.

Host Range

Those members of the *Solanaceae,* which have been thoroughly tested, are susceptible to infection as follows:—

Local lesions but non-systemic—Tobacco, *Nicotiana glutinosa*, Datura spp., Petunia** (garden varieties).
Systemic without local lesions—Tomato, *Lycopersicum pimpinellifolium, Physalis floridana, P. Peruviana.*
Local lesions and systemic mottle—Capsicum of several strains including paprika and tabasco.
*In hot weather infection in these plants is systemic to the degree that necrosis advances uniformly along the veins down the petioles into the stem and may finally kill the plant.

Plants of other families which failed to react include cowpea, broad bean, french bean, cucumber, mustard and lettuce. A wider host range has not been tested.

Root Necrosis Reaction

Other than in tomato a necrosis of root tissues was observed only in *L. pimpinellifolium* and every attempt to reisolate the virus from the roots of tobacco, *N. glutinosa,* french bean and lettuce has been unsuccessful.

Thirty-five of thirty-seven varieties or hybrids of varieties of tomato have proved to be fully susceptible to the root necrosis phase of the disease. The two strains which failed to develop typical root symptoms were obtained from Dr. J. M. Walter of the University of Florida, who had bred them for resistance (not immunity) to tobacco mosaic virus (T.M.V.). However, the virus became systemic in Walter's strains and caused necrosis when transferred from them to susceptible varieties.

The vascular necrosis appears in the roots of susceptible tomatoes in from seven to ten days after inoculation and is well advanced by fourteen days. The degree of reaction is influenced by the temperature of incubation, being most intense in winter months and absent, or nearly absent, under summer conditions.

Physical Properties of the Virus

The virus remained infective after exposure, in tomato sap, to 85°C for ten minutes. Its critical thermal inactivation point has not yet been determined. During temperature inactivation tests the temperature coefficient of the virus was observed to be large.

Powder prepared by drying and grinding leaves of infected tomatoes still contains active virus after a storage period of two years at room temperature. There is no apparent loss of titre.

Inoculum prepared by macerating infected tomato leaves in phosphate buffer remained active after twenty one days at room temperature, the longest period tested.

The virus remained infective when tested six months after chemical "purification" by the method described by Bawden (1950) for Tobacco Mosaic and other anisometric viruses.

Serological Relationship

A strong positive reaction was obtained when clarified juice from infected tomato leaves was tested against antiserum, supplied by Dr. Milton Zaitlin, for each of two different strains of T.M.V.

Cross Protection

Tomato plants develop vascular necrosis of the roots when inoculated simultaneously with T.M.V. and the virus of drop head wilt (T.R.N.V.). However, if plants are inoculated with T.M.V. three or more days before inoculation with T.R.N.V. no necrotic reaction occurs. Even when the interval between the introduction of the two viruses is as much as 14 days T.R.N.V. is not prevented from invading the tomato plant by the presence of T.M.V. but develops symptomlessly within it. This is shown by the formation of numerous lesions on tobacco leaves rubbed with sap from the leaves or roots of such plants.

In tobacco the presence of T.M.V. confers no immunity against T.R.N.V. since the formation of typical local lesions by T.R.N.V. is not prevented when this virus is rubbed on

tobacco plants systemically infected with T.M.V.

Interaction with Potato Virus X

When tomato plants, systemically infected with potato virus X, are inoculated with T.M.V. they develop severe mottling and necrotic areas on the leaves and typical double virus streak symptoms on the stem. There is no root necrosis. When T.R.N.V. is used instead of T.M.V. mottling is much less intense although the other symptoms develop. Severe root necrosis also develops except in summer. Under the conditions in the glass house where these observations have been made neither T.M.V. nor T.R.N.V. cause streaks to appear on the stems of tomato plants, infected with Potato Virus X, during summer months.

Discussion

Drop head wilt has never been recorded in the field and until 1958 it was believed to occur only in glasshouses at Mona Vale-Warriewood. However, in 1958 and again in 1959 tomato plants affected with drop head wilt have been received from glasshouses at Buronga in the south-west of New South Wales, some five hundred miles from Sydney. Varieties grown at Buronga are different from those grown in Sydney and enquiries have failed to reveal any exchange of seed or plants between the two districts.

It therefore seems possible that the disease, which has apparently not been described elsewhere, may be of general distribution. This is the more likely as the symptoms of drop head wilt so greatly resemble a fungus root rot that the virus nature of the disease was not detected until various fungus isolates failed to reproduce the condition and the problem was attacked in a systematic manner.

Conclusion

It is considered that the causal agent of drop head wilt of tomato is a hitherto undescribed strain of tobacco mosaic virus.

Acknowledgment

Photographs by Mr. J. Titze.

Bawden, F. C. (1950)—Plant Viruses and Virus Diseases (page 172).

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Book Review

Mist Propagation of Cuttings

By Patricia Rowe Dutton

Commonwealth Bureau of Horticulture and Plantation Crops, Digest No. 2. *Obtainable from the C.A.B. Liaison Officer at* 314 *Albert Street, East Melbourne, C.*2., *Victoria. Price* 12/6.

This easy-to-read publication will be found interesting and useful by any professional or amateur nurseryman.

It deals clearly with every aspect of the process, explaining the principles of mist propagation and describing the structures and apparatus used.

The information on rooting media, nutrition, and hardening off is brief, sound and to the point. The bibliography will assist those interested in further details. An appendix contains the name of some firms manufacturing mist equipment. This is a practical inclusion in a publication of this kind. A table of results obtained apparently by numerous practical workers is comprehensive and gives the number of days to potting with a description of rooting media and other vital details for over 1,000 different cuttings. The table covers fruit trees, shrubs, roses and other ornamentals and should be a useful starting point for those commencing mist propagation or those rooting species new to them.

The author has tried and succeeded very well in giving a full cover of literature and experiences with mist propagation up to date.

Theses on which higher Degrees were Awarded in the Faculties of Agriculture of Australian Universities – 1959

University of Adelaide

M.Ag.Sc.	C. H. S. Dolling	The inheritance of horns in sheep.
M.Ag.Sc.	C. B. Wells	Soil mosaics in the Barossa district, S.A.
M.Ag.Sc.	Jagdishwar Nath	Studies on soil fumigation with Vapam for controlling soil-borne diseases of peas.
M.Ag.Sc.	N. A. Naidu	The influence of nitrogen supply on yield and nitrogen content of three wheat varieties.
M.Ag.Sc.	R. H. Sedgley	Effect of mechanical impedance and oxygen on seedling emergence.

University of Melbourne

Ph.D.	M. Freer	A study of pasture utilization by dairy cows.
M.Agr.Sc.	K. Aung	A study of forms of accumulation of phosphorous of some Victorian soils.
M.Agr.Sc.	P. Baxter	The nutrition of deciduous fruit trees in Victoria.
M.Agr.Sc.	J. B. Coombe	Some problems of sheep nutrition under Australian pastoral conditions.
M.Agr.Sc.	R. J. de Laine	A survey of farm water supplies in central parts of Victoria, 1956-57.
M.Agr.Sc.	J. Sabine	The selective appetite for sodium established by sheep.

University of Queensland

M.Agr.Sc.	V. R. Catchpole	Sorghum silage.
	R. W. Downes	The potential of the genus *Dichanthium* in Queensland with particular reference to *D. sericeum*.
	F. R. From	Labile nitrogen of a Darling Downs black earth from Bowenville, Queensland.
M.Agr.Sc.	Rose P. Kleinschmidt	Systematic biological and economic studies of some Agromyzidae (Diptera) from Queensland.
M.Agr.Sc.	R. Milford	Criteria for expressing the nutritional value of subtropical grasses.

University of Sydney

Ph.D.	D. J. Goodchild	The effect of light on the synthesis of tobacco mosaic virus.

Ph.D.	J. McPhillips	Physico-chemical and biological aspects of acid production and methylene blue reduction in milk.
M.Sc.Agr.	T. Biegler	Alternating current polarography of cystine and the oxidation potential of the system cystine-cysteine.
M.Sc.Agr.	P. B. Goodwin	The emulsifying ability of blood serum.
M.Sc.Agr.	S. G. Gray	A study of the variation, hybridisation and the F_1 generation of interstrain crosses of *Leucaena glauca*.
M.Sc.Agr.	T. Passlow	Bionomics and control of the sorghum midge *Contarinia sorghicola* (coq.) in Queensland.
M.Sc.Agr.	G. S. Purss	Studies on the stem rot of cowpeas in Queensland.
M.Sc.Agr.	T. F. Reardon	Quantitative studies of oestrogens in the ewe.
M.Sc.Agr.	E. Vitols	Studies on the assimilation of ammonia by bacteria.
M.Sc.Agr.	J. R. Wilson	The influence of time of tiller origin and nitrogen level on the floral initiation and ear emergence of four pasture grasses.
M.Sc.Agr.	C. J. Driscoll	Cytogenetical studies of wheat in relation to monosomic analyses and disease resistance derived from *Agropyron elongatum*.
M.Sc.Agr.	R. A. Date	Growth and survival of the root nodule bacteria.

University of Western Australia

D.Sc.(Agric.)	R. O. Statyer	Studies of plant-soil water relationships.
Ph.D.	J. S. Gladstones	A study of the genetics and agronomy of the genus *Lupinus* with particular reference to varieties of potential value in W.A.
Ph.D.	C. A. Parker	Non symbiotic nitrogen fixation and the nitrogen status of soils.
Ph.D.	M. Somers	Factors influencing the nitrogen fractions in ruminant saliva.
M.Sc.(Agric.)	M. L. Parker	Farm planning. A consideration of its application to agricultural expansion using data derived from a survey of the Kojunup district of W.A.
M.Sc.(Agric.)	J. T. Reeves	The relationship of yield and protein in wheat.

Thesis Summary

The Effect of Light on the Synthesis of Tobacco Mosaic Virus

The effect of light on the development of local necrotic lesions of tobacco mosaic virus (TMV) was investigated in *Nicotiana glutinosa* L. and *Datura stramonium* L. In both cases local lesions appeared at an earlier time, and reached their maximum number in a shorter period, as the light intensity was increased, from darkness to 950 ft candles intensity.

In addition to this effect more lesions are developed in light than in dark. This depression in lesion numbers by darkness was resolved into two effects, a major effect and a minor effect. The time of action of the major depressing effect of darkness for the U1 and U2 strains of TMV was found to be correlated with the short time period after inoculation, when the *in vivo* sensitivity of the strains to ultraviolet light (UV), remains constant. The absence of virus multiplication during this period was demonstrated, and it is probable that, during this period, the protein sheath is being removed from the ribonucleic acid (RNA) prior to multiplication.

The major depressing effect of darkness, on lesion numbers, is not affected by temperature, and can be reproduced under greenhouse conditions, but light quality may be an important factor since green light of low intensity has a similar effect to darkness.

The minor depressing effect of darkness was shown to persist after the major depressing effect had ceased to be of importance. It is a small magnitude effect.

Virus movement from cell to cell in a leaf, as represented by the growth of local lesions on *N. glutinosa,* was shown to be enhanced in darkness. However, the amount of virus development in the lesions, per unit area, was found to be similar in both light and dark.

In the systemic host *Nicotiana tabacum* L. darkness inhibits the amount of TMV formed in both young and old leaves. In young leaves this inhibition was found to be correlated with the relatively small amount of cytoplasmic leaf protein produced. In addition to the virus effects, young tobacco leaves placed in the dark were found to undergo a rapid loss of cytoplasmic protein for a period of 48 hours, under constant environmental conditions.

Following this depression, the amount of cytoplasmic leaf protein increased to a maximum value and then dropped rapidly as the length of the dark period increased. Furthermore, it has been shown that a tobacco leaf will recover the ability to synthesize cytoplasmic leaf proteins after a two day period in the dark, but not after seven days in the dark.

D. GOODCHILD

Awarded the degree Ph.D. by the University of Sydney.

Studies on Stem Rot of Cowpeas in Queensland

The disease known as stem rot of cowpeas is described. The causal organism is shown to be an undescribed species of *Phytophthora* for which the name *Phytophthora vignae* n. sp is proposed. This species has non-papillate or inconspicuously papillate sporangia measuring 24-72μ x 15-54μ, amphigynous antheridia measuring 12-27μ x 9-18μ and oogonia measuring 27-42μ x 24-46μ. The oospores are smooth being 18-32μ in diameter. The sporangia are rarely formed on solid media but occur frequently on diseased lesions particularly under moist conditions. Sexual organs are produced abundantly on artificial media

and in diseased tissue. The fungus is pathogenic to apple and grows in a concentration of 1/4,000,000 malachite green. It makes maximum growth at a temperature of 28-30°C. and fails to grow above 34.5°C and below 10°C.

The soil borne phase of the pathogen was investigated and it is concluded that although *Phytophthora vignae* is incapable of competing satisfactorily with soil saprophytes it is able to survive as oospores in the soil for at least twelve months.

It was found that a high moisture content in infested soil was not required to give severe infection of susceptible varieties but did increase disease in varieties with some resistance. Under such high moisture conditions sporangia can produce lesions and may account for the rapid spread of the disease in uninfested soil. Free moisture is considered to act as a disseminating agent.

Under experimental conditions it is shown that aggressive parasitism can be expected only between rather narrow limits of temperature compared with the range over which the fungus can grow.

The reaction of varieties to the disease was assessed under both glasshouse and field conditions. It was concluded that varieties may be grouped roughly into three classes with respect to their resistance. The first group contains varieties such as Poona and Reeves which are susceptible under all conditions. The second group includes such varieties as Malabar and Giant which, while susceptible under severe glasshouse conditions, show variable resistance in the field. Within this group the effect of previous history of the land and environmental conditions upon infection is clearly evident. The third group contains varieties such as Blackeye 5 which are resistant under all conditions.

The use of resistant varieties offers the most effective means of control.

C. G. PURSS

Awarded the degree M.Agr.Sc. by the University of Sydney.

Some Problems of Sheep Nutrition under Australian Pastoral Conditions

This thesis is presented in two parts—part 1 dealing with the utilization of low-protein roughages by sheep, with particular reference to the use of urea as a supplement; and part 2 with the nutrition of lambs under grazing conditions.

Part 1—The value of urea as a supplement for roughage high in fibre and low in protein was first demonstrated in South Africa and later verified by work in Victoria. The aim of the present work was to investigate the possibility of urea toxicity under these feeding conditions, and to examine the effect of higher levels of urea in the diet.

In an initial experiment, it was established that sheep could consume up to 100 g urea per day without any signs of toxicity. In this experiment, the urea was given as a solution in molasses and water, mixed intimately throughout the daily ration of roughage. The absence of toxicity was thought to be due to the method of feeding, which ensured that the daily ration of urea was consumed gradually.

To test this hypothesis, an experiment was carried out with fistulated sheep to investigate the effect of urea on the levels of pH and ammonia-N in the rumen. The urea was administered either as described above or as a drench directly into the rumen. Samples of rumen liquor were taken immediately before the administration of urea, and then at various intervals throughout the day.

While the sheep were on the basal ration of hay, or hay plus molasses, the rumen NH_3-N levels through the day varied between 6-14 mg per 100 ml, and the rumen pH between 6.3-6.8. The addition of 100 g urea to this diet, as a solution mixed with the hay, caused a marked rise in rumen NH_3-N levels

to about 50 mg per 100 ml within the first hour after feeding, and this level was maintained, with slight fluctuations, throughout the day. Similarly, the rumen pH rose to about 7.2 and remained at that level. When the urea was fed in this way, so that ingestion was gradual, the rumen NH_3-N levels never exceeded 80 mg per 100 ml, rumen pH always remained below 7.3 and no signs of toxicity were observed. In contrast to this, when only 25 g urea were administered as a drench, rumen NH_3-N levels rose to about 114 mg per 100 ml, there was a concurrent rise in pH to 7.9, and some external signs of toxicity appeared.

In a third experiment, the effect of molasses and urea as supplement to a diet of chopped oaten straw (32.6 per cent. crude fibre, 3.0 per cent. crude protein) was studied. The straw was supplied *ad lib,* and the supplements fed at the rate of 240 g molasses per sheep per day, and 15 or 30 g urea per sheep per day. So that toxicity would present no problem, the molasses and urea were dissolved in water, and the solution mixed throughout the straw.

Supplementation with urea caused significant increases in food intake and wool production, and resulted in maintenance of body weight in contrast to an average loss of 2 lb per week in unsupplemented sheep. Molasses fed without urea had no beneficial effect. There was no significant difference between the two treatments with urea in food intake, wool production or liveweight changes.

Part 2—This work was carried out as part of a study of the development of the rumen in grazing lambs, and involved the determination of the milk yield of the grazing ewe. Two techniques were used—the "lamb suckling" technique, and a more recent method using injections of oxytocin. Lactation curves for 15 ewes for the first 10 weeks of lactation were established using both methods, and the results from each method compared. In addition, observations on growth rates of the lambs were used to establish correlations between milk yield of the ewe and growth of the lamb.

The oxytocin technique gave consistently higher results for milk yield than did the lamb suckling technique, this difference being significant at the 1 per cent. level for 4 weeks, 7 weeks and 10 weeks of lactation. The correlation between milk yield and lamb growth rate for the first 4 weeks of lactation was 0.69 with the lamb-suckling technique and 0.73 with the oxytocin technique.

From a discussion of the errors involved in each method, it was concluded that the lamb suckling technique probably gives a more accurate indication of the amount of milk available to the lamb in the field.

J. B. COOMBE

Awarded the degree M.Agr.Sc. by the University of Melbourne.

Physico-Chemical and Biological Aspects of Acid Production and Methylene Blue Reduction in Milk

Factors in milk causing variations in acid production by some species of lactic streptococci have been investigated and a study undertaken of certain aspects of methylene blue reduction.

Four factors were found to influence acid production in the milks examined:

1. a stimulatory effect causing an increase in the initial rate of acid production;
2. a buffering effect which determined the maximum amount of acid produced;
3. an inhibitory effect partly due to depression of the initial pH of the milk by severe heat treatment;
4. an inhibitory effect caused by agglutination of certain strains of streptpococci and the removal of the agglutinated organisms from the bulk of the milk by rising cream.

The stimulatory factor operated independently of the buffering effect and could almost certainly be responsible for variations

in the keeping quality of the milk as determined by the methylene blue test. Variations in the buffering capacity of milk, however, are not likely to have any influence in this respect. Chemical analysis and protein depletion studies revealed that considerable differences in the buffer constituents of milk could occur without significantly affecting the buffering capacity.

Heating milks at temperatures between 70° and 100°C. for periods of up to two hours had an insignificant effect on the acid-base equilibrium of milk but autoclaving for 30 minutes or longer caused a marked fall in initial pH and a rise in titratable acidity. In general, acid production by *Str. lactis* was progressively inhibited with time and temperature of heating. Acid production in the autoclaved milk was partially restored by adjusting the initial pH and fully restored by adding the culture in a nutrient broth. It is concluded that the inhibitory effect of prolonged autoclaving is partly due to the lowering of the initial pH of the milk.

Raw milk was shown to contain an inhibitor specific for certain strains of *Str. cremoris*. This inhibitory effect proved to be due to naturally occurring agglutinins which exhibited some degree of specificity. These agglutinins were also demonstrated in the serum of the cow, the rabbit and the hen. It was shown that agglutination in milk had a beneficial effect on keeping quality.

The determination of keeping quality in terms of ferricyanide-reducing substances revealed no significant differences between the milks studied. Titration with sodium hydrosulphite as a means of demonstrating differences in the poising of milks to changes in redox potential was not practicable owing to the influence of dissolved oxygen. The milk fat greatly retarded reabsorption of oxygen by de-aerated milk and it is suggested that in this way the fat could be responsible for variations in methylene blue reduction times. Only relatively small differences were observed in initial oxygen content and redox potentials of normal milk and in every case where these were significantly low, the milk was shown to have a high bacterial count.

Several new techniques and modifications of existing ones were developed during the course of this work. An "electrodeless" conductivity cell was used to follow acid production in inoculated milk and to study its effect on the constituents of the milk. The Adam's paper strip method was used to determine both total solids and fat and agglutination was demonstrated by a ring test using stained antigen. A slide technique employing phase-contrast microscopy was developed to overcome difficulties associated with unstable controls in agglutination tests. It was shown that the dropping mercury electrode could be used to determine oxygen content and to follow changes in redox potential in the same sample of milk.

J. McPHILLIPS

Awarded the degree Ph.D. by the University of Sydney.

Quantitative Studies of Oestrogens in the Ewe

Pure preparations of three natural and five synthetic oestrogens were assayed for potency using as test animals ovariectomised crossbred ewes (Border Leicester x Merino) running under field grazing conditions. As far as possible, the same seventy-two animals were used for each assay. The animals were given six injections each of twenty milligrams of progesterone in oil every second day. Commencing forty-eight hours after the last progesterone injection, the oestrogen being assayed was injected subcutaneously. Three dose rates were used, each being given either as a single injection or as three equal injections twelve hours apart.

Two criteria of response were used; the oestrous behaviour resulting in service by a ram and the presence of cornified epithelial

cells together with, at most, very few leucocytes in smears taken from the cervical region of the vagina on the second, third, fourth or fifth day after oestrogen injections commenced.

Under the experimental conditions, oestradiol benzoate, oestradiol, hexoestrol and stilboestrol were found to be highly potent, dienoestrol, oestrone and oestrone benzoate were moderately potent, and oestriol possessed only low potency.

The potency of the three stilbene derivatives (hexoestrol, stilboestrol, and dienoestrol) was increased by injection in three doses, while the potency of the steroid hormones tested was little affected by the number of doses.

It was concluded that the relative potencies of oestrogens tested in the ewe were of the same order as those found in rodents. Stilbene-type oestrogens appeared to have a different reaction pattern from steroid oestrogens.

Fourteen ewes which received a constant dose of oestradiol benzoate after the progesterone treatment throughout the experimental series, showed a random variation in sensitivity to oestrogen as measured by vaginal smears and a cyclic variation as measured by oestrous behaviour, the latter being correlated with the mean liveweight of the animals, daylight hours and possibly other environmental factors.

Seasonal variation in sensitivity to oestrogen could account for the anoestrous season and the phenomenon of "silent heat" as periods of insensitivity to endogenous oestrogens. There were also indications that nutritive state may affect sensitivity to oestrogen.

T. F. REARDON

Awarded the degree M.Sc.Agr. by the University of Sydney.

A Study of Variation, Hybridization and the F_1 Generation of Inter-strain Crosses in *Leucaena glauca*

A study of variation in *Leucaena glauca* has shown that the species comprises a number of strains which are fairly uniform and stable, although not completely so.

Strains may be grouped into three types on the basis of growth habit, vegetative vigour, and time of flowering.

L. glauca is essentially autogamous but with a small amount of outcrossing. Methods of emasculation and cross-pollination have been developed and tested.

The F_1 generation of inter-strain crosses has been studied. Growth habit differences have a genetic basis, tallness being dominant over shortness; modifying factors also appear to be involved. Stem-tip pubescence is inherited as a single recessive; this character should be useful as a genetic marker. Petiole pigmentation appears to be fairly simply inherited, with one or two gene pairs, but variation in expressivity makes the character somewhat difficult to define.

Quantitative character differences have been studied using Duncan's multiple range tests for the comparison of means. The means for several quantitative measurements in the F_1 generation tend in a majority of instances to approximate those for the parent line with the higher value, indicating dominance as the major factor in controlling size inheritance. Some instances of F_1 means exceeding those of the higher parent indicate that heterosis also occurs. Much, but not all, of the quantitative variation found in inter-strain crosses should therefore be fixable.

There are indications that strains of *L. glauca* possess differences in combining ability.

The principal objectives of breeding work with *L. glauca* are to obtain growth habit

readily compatible with intense grazing by cattle, and to obtain the maximum forage yielding ability. Breeding in this species should follow pedigree culture methods, raising large F_2 populations in order to secure rare combinations of multiple genes.

L. glauca offers some advantages as a subject for the study of quantitative inheritance, particularly in relation to the inheritance of forage yielding ability.

S. G. GRAY

Awarded the degree M.Sc.Agr. by the University of Sydney.

Non Symbiotic Nitrogen Fixation and the Nitrogen Status of Soils

In this work, particular attention was paid to methods of counting non-symbiotic bacteria, to factors affecting their N_2 fixing efficiency and to soil nitrogen changes in the field. The following is a condensed summary of the thesis material, most of which has been published.

Counting Methods. The practice of using nitrogen-free selective media was found to be completely unsatisfactory for the enumeration of organisms such as *Clostridium* and *Azotobacter*. Nitrogen-fixing bacteria were found in all the soils examined, the clostridia, particularly, being always present.

Efficiency of Nitrogen Fixation. The anaerobe *Clostridium* was shown to be capable of fixing at least as much nitrogen per unit of carbohydrate supplied as the aerobe *Azotobacter*.

Azotobacter fixes more nitrogen at 5 per cent. than at higher concentrations of oxygen, both the rate and the efficiency of fixation being greater at this oxygen concentration. The inhibition of nitrogen fixation by oxygen was found to be competitive, suggesting that O_2 and N_2 may compete for active sites on the nitrogenase enzyme.

Soil Nitrogen Changes. Two wheatbelt soils were examined. The first, a fine sandy loam carrying capeweed and wimmera rye-grass between crops, was estimated to have gained nitrogen at the rate of 15 lb per acre per annum. The second soil, a silty clay loam typical of the better wheat growing soils of Western Australia, gained significant amounts of nitrogen while under legume-free grass sward. There was no evidence of movement of nitrogen in the soil profile, suggesting that the gains, amounting to 50-60 lb N per acre per annum, were derived from atmospheric nitrogen. The nitrogen increases appeared to have been associated with the growing plant, as treatment with ground straw did not cause an increase in soil nitrogen.

It was concluded that the nitrogen gained under grass sward may have arisen from the activities of organisms living on the roots of the plants. Thus the term "free living" rather than "non-symbiotic" might be more suitable as a description of those nitrogen-fixing micro-organisms which are found outside the organised nodular tissues of plants. Since there is no specific energy requirement for nitrogen-fixation, the free living nitrogen-fixers should compete successfully with other soil microbes for energy-yielding materials, especially when the available soil nitrogen is low. In normal soils further conditions would be:

1. the presence of adequate amounts of energy yielding substances, and
2. low oxygen concentration in the soil water.

A technique of anaerobiosis using iron wool to remove oxygen, a routine method for the estimation of total nitrogen in microgram amounts, and an examination of some methods for the estimation of total nitrogen in soil are described in the Appendix.

G. A. PARKER.

Awarded the degree of Ph.D. by the University of Western Australia.

The Nutrition of Fruit Trees in Victoria

Fruit growing in Victoria is carried on under a wide range of soil and climatic conditions and almost all known nutritonal deficiencies and excesses have been found to occur in this state. This work deals with their occurrence, symptoms, diagnosis and treatment based on the accumulated experience of horticultural research workers of the Victorian Department of Agriculture, long-term field trials as well as experiments conducted by the author both in commercial orchards and in the laboratory.

Particular emphasis is given to potassium deficiency in pome fruit in southern Victoria and its interrelation with other elements as well as its effect on fruit quality and tree health. Trials with urea sprays on apples and the effect of nitrogen on fruit quality are reported also the use of simple chemical tests to determine nitrogen uptake and status in apples and manganese excess in peaches.

Many experiments were concerned with the search for a practical treatment of lime-induced chlorosis of stone fruit growing under irrigation in northern Victoria, other trials concern zinc, copper and manganese deficiencies of apple trees.

The last chapters discuss methods of diagnosis, particularly the interpretation of leaf analyses and simple tissue tests and offers advice on planning and statistical lay-out to those about to start fertilizer trials in private orchards.

A short version of this subject has been written by the author as a bulletin for fruit growers *The Nutrition of Fruit Trees* and published by the Department of Agriculture, Victoria.

P. BAXTER.

Awarded the degree M.Agr.Sc. by the University of Melbourne.

Studies of Soil Fumigation with Vapam for Controlling Soil Borne Diseases of Peas

A study was made of Vapam 4-S as a partial sterilization agent of soil especially in relation with soil sickness of peas at Cooltong, South Australia.

Three field trials were laid out at Cooltong during 1957-58. It was discovered that the fumigant leaches into the subsoil when application is followed immediately by overhead sprinkler irrigation. This position was rectified by a new method of split application. With this method, fumigant, at a rate of 337 to 400 lb per acre resulted in a reasonable crop of peas when no peas could be harvested from untreated plots. A collateral advantage was the complete control of weeds in the treated area.

Particular attention was devoted to study the ecology of fungi in the partially sterilized soil and the following conclusions were made:

1. Although one reasonable crop of peas could be grown in plots treated at 337 lb and 400 lb per acre the effect on the fungal flora was very partial, i.e., although the population was depressed very few species were completely eliminated and saprophytic survivors were unable to compete effectively with the surviving pea pathogens. Recolonisation by pathogens was shown to be fairly rapid and by the end of the fifth month after treatment their population appeared to be higher than before treatment.

2. In plots treated at 1,000 lb per acre a large number of fungal species including pea pathogens were eliminated. In these plots in one trial the leading recolonizer after a period of five months was *Pythium ultimum* and in another season the leading recolonizer was *Trichoderma*.

3. It was concluded that soil sickness of peas at Cooltong was due mainly to *Fusarium oxysporum* and *Fusarium solani*. This particular disease syndrome in European literature has been referred to as St. John's disease. It would therefore follow that this syndrome present in Europe and in England is present also in South Australia.

4. It is suggested that the genetical approach to the St. John's Disease syndrome could be developed if the breeder attempts to use more complex forms of resistance in the breeding programme.

J. NATH.

Awarded the degree M.Ag.Sc. by the University of Adelaide.

The Potential of the Genus Dichanthium in Queensland with Particular Reference to *Dichanthium sericeum*

The genus *Dichanthium* has its centre of distribution in Southern Asia with some representation in Africa and Australia. The group has not been subjected to selection by humans so does not include any improved strains though some species are regarded as valuable native grasses in certain countries.

As *D. sericeum* has been replaced in many parts of Queensland through overgrazing, its attributes were evaluated to ascertain whether or not reseeding is warranted. It was concluded that the species, though valuable in some respects, lacks the ability to grow in winter and is not capable of creeping growth. Some strains of introduced species; *D. annulatum, D. aristatum, D. caricosum,* and *D. Papillosum,* remain green throughout the winter at Gatton and others creep vigorously. In an attempt to find to which areas of Queensland these species might be adapted, various systems of climatic classification were used.

However, should selection in the genus have only limited value, it may be necessary to initiate a breeding programme. To this end, the breeding systems in the genus were studied. Although one tetraploid plant was found in an extensive seed collection of *D. sericeum,* the species is essentially diploid and is sexually reproducing, with a high degree of self-fertilization assured by cleistogamous flowering. The introduced species on the other hand, are polyploid complexes. *D. annulatum* contains some sexual diploids but facultative apomictic tetraploids are more common. *D. papillosum* is a hexaploid obligate apomict.

It appears that while apomixis has potential value for fixing superior types, it presents a barrier to progress by plant breeding. This barrier might be overcome if more were known of its biochemical and physiological basis. A preliminary approach to such a study was suggested.

It was concluded from this study that the germplasm of the genus *Dichanthium* is potentially very valuable and could conceivably contribute much to the improvement of Queensland's pastures.

R. W. DOWNES.

Awarded the degree M.Agr.Sc. by the University of Queensland.

Soil Mosaics in the Barossa District, South Australia

The problem tackled is to analyse the soil forming environment in an area where there is an intimate, fine-grained, heterogeneous distribution of calcimorphic soils. They belong to great soil groups each customarily associated on the broad scale with separate and

distinctive climatic or vegetation environments.

Field and laboratory work and historical records provide data for relating the origins and distributions of the soils to their present and past environments. Some stress is laid on using simple statistical descriptions of profile morphology, chemistry, physiographic and topographic distribution and other amenable properties.

A soil mosaic is here defined as "a mapping unit for areas in which a number of distinctly different kinds of soils occur in very intimate but variable association with each other, but without any constant relationship to topography".

The broad scale distribution of mosaic units is closely associated with the underlying geological material and with the re-worked remnants of a postulated fine-textured Tertiary overmass. They are also found in the same pattern as a reconstruction of the original vegetation cover and their distribution is compatible with present climatic differences, though not controlled by them.

A detailed study of the sites and conditions of formation of the individual soils as they occur in the several mosaics is used to explain how the same soils appear in most of the mosaics but in different proportions in each. The soils concerned are black earths, rendzinas, Australian brown earths and red-brown earths. Their occurrence throughout all the mosaics is related reasonably consistently to specific conditions of parent material, more particularly with how arenaceous, argillaceous or calcareous it is, slope position, shape of slope, and drainage conditions especially as they affect carbonate redistribution and hydrology.

The analysis helps to put into perspective the phenomenon of four supposedly zonal soils occurring together in an intimate and variable pattern over small areas.

C. B. WELLS.

Awarded the degree M.Agr.Sc. by the University of Adelaide.

The Influence of Time of Tiller Origin and Nitrogen Level on the Floral Initiation and Ear Emergence of Four Pasture Grasses

The present study was undertaken to determine more closely the behaviour of individual tillers of four grass species throughout the growing season. It was hoped that the results of such a study would be of value in planning pasture management with more precision.

The work was carried out at the Palmerston North Station of the Grasslands Division, D.S.I.R., New Zealand. From May 1958 to February 1959 groups of newly emerged tillers of New Zealand certified perennial ryegrass, Italian ryegrass, cocksfoot and timothy were labelled at approximately monthly intervals. The date of floral initiation, ear emergence, leaf number at ear emergence, and percentage of fertile tillers was recorded for each group. The influence of two levels of nitrogen was also examined.

Despite large differences in their time of origin, winter and early spring tillers of perennial ryegrass, Italian ryegrass, and timothy all initiated floral primordia within a relatively short period. In each species ear emergence followed the same pattern, the majority of heads emerging within the 3-4 weeks following the first recorded ear. Mean leaf numbers at ear emergence decreased with decreasing age of tillers, the minima reached being 6 for perennial ryegrass, 7 for Italian ryegrass, 9 for cocksfoot and 14 for timothy.

In cocksfoot and timothy the percentage of fertile tillers was high only among those formed before mid-winter, whereas in perennial and Italian ryegrass fertility remained high even for tillers formed up to late spring. High nitrogen resulted in earlier floral initiation and ear emergence, and a greater percentage of fertile tillers. The effect was most marked for cocksfoot.

The importance of tillers originating at different times of the year, for either seed or herbage production is discussed in relation to the pattern of tiller development found in this study.

The effect of high temperature on flowering was examined on a small scale for perennial ryegrass plants grown in controlled environment cabinets. High temperature caused almost complete inhibition of ear production.

J. R. WILSON

Awarded the degree M.Sc.Agr. by the University of Sydney.

A Study of the Genetics and Agronomy of the Genus Lupinus with Particular Reference to Varieties of Potential Value in W.A.

Agronomic evaluation of a large number of locally selected and introduced species and strains of *Lupinus* showed that four species (*Lupinus luteus, L. albus, L. angustifolius* and *L. digitatus*) have considerable potential for those parts of South-Western Australia with an annual rainfall of 16-20 inches or more. Of these species, bitter varieties of *L. angustifolius* and *L. digitatus* have already been grown commercially in limited areas for a number of years to provide summer feed for sheep and as a green manure crop.

Particular interest centred on alkaloid-free, or sweet varieties of *L. luteus, L. angustifolius,* and *L. albus.* These were found to grow as vigorously as the bitter varieties. However, the susceptibility of alkaloid-free varieties of *L. luteus* to red-legged earth mites and lucerne-fleas (*Halotydeus destructor* and *Smynthurus viridis* respectively) is a disadvantage, while all alkaloid-free varieties are more liable to grazing during the growing period, being much more palatable to stock and rabbits than bitter types.

The most promising variety tested was the Weiko III variety of *L. luteus,* which appears suitable for development as a grain crop in areas with an annual rainfall of 20 inches or more. It is well adapted to the sandy and gravelly soils characteristic of these areas, alkaloid-free, non-shedding, and free of hard seeds. The unusually high protein content of the seeds, about 40 percent., would make them a valuable protein source. Alkaloid-free forms of *L. albus* may also prove useful as grain legumes, but need more fertile soils than *L. luteus.* Within *L. angustfolius,* the most suitable alkaloid-free variety proved to be Borre. However, no non-shedding strain has yet been found within this species. The value of Borre as a replacement for existing bitter lupin varieties for grazing will depend largely on whether European findings that alkaloid-free lupins do not cause the disease lupinosis in sheep are confirmed locally.

In addition to the general agronomic investigation, three particular problems were selected for closer study.

1. The taxonomy of lupins found in Australia was studied by morphological comparison, chromosome counts, and attempted interspecies crossing. It was shown that the 'West Australian blue lupin' could not be *L. pilosus* L. or *L. varius* L., as previously believed, but that it was probably *L. digitatus* Forsk.
2. The development of seed-coat impermeability in *L. digitatus* during storage was investigated and found to be closely dependent on seed moisture content.

3. Air-dry seeds of *L. digitatus* were subjected to various levels of X-ray dosage. The maximum dose allowing 50 per cent. survival was of the order of 60-80 Kr. A study of the incidence of mutations in the progenies of individual branches of X_1 plants yielded information on the ontogenetic development of the plants. A wide variety of mutations was recovered, including one early-flowering line of possible value.

J. S. GLADSTONES

Awarded the degree Ph.D. by the University of Western Australia.

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The Acting Chief,
Division of Land Research and Regional Survey,
C.S.I.R.O.,
P.O. Box 109, City, Canberra, A.C.T.
by 3/10/1960

Letters

Status of Agriculture

Dear Sir,

A letter of mine dealing with the above subject was published by you in the September 1959 issue of this Journal. It received very favourable comment from many of my contemporaries here and in the Eastern States. They seem to think the nail has been hit on the head and yet these people will develop the same characteristics which we criticise now. We have had no training in administration and yet expect to get by with the few ideas and self confidence we pick up along the line.

Administration is a complex business capable of a systematic and scientific approach and as with any such subject, self teaching can be pitifully inadequate.

It is inevitable that men with good intentions but without administrative training will become inefficient. Errors cause them to develop an authoritarian attitude to uphold and retain their position.

Criticism of those who have gone through this process can do no good, it is up to the next generation of leaders to do their best in completing their education in administration.

I suggest that:—

1. Every AIAS Branch engage speakers on office and personnel management to speak to well attended meetings.

2. Administration be included in the Agricultural Degree course, if necessary at the expense of less important subjects.

3. Graduates should seek and be given every opportunity to attend such courses.

4. Special short courses be organised for field workers not able to attend regular courses.

I suggest finally that we stop thinking that administration is something we will have to do if we reach higher positions, right from the start we should administer ourselves and we don't even learn how to do this.

Yours, etc.,
B. a'B. MARSH.

Vacation Grants for Agricultural Students

Dear Sir,

Perhaps the Institute may care to explore the feasibility of the following suggestion:

that firms be asked to make grants available to agricultural science students to enable them to assist in research or service work in government departments or private industry during the summer vacation.

The grants need not be large, say, of the order of £150-£200 and it should not greatly matter if they were offered with or without encumberment. The applicants need only possess keenness, good scholastic standing, and the consent or recommendation of their professors or senior lecturers. The scheme could be administered by the Institute.

I have several reasons for putting forward this suggestion, all of which are already widely appreciated. Thus, it is well known that many students now have financial difficulties; that agricultural courses are heavily overloaded; that students have difficulty choosing careers; that students fail, often, to appreciate the potential significance of gobbets of information placed before them under the present system of "education"; that students' interest in agriculture frequently lags because no one provides them with tangible evidence of their value; that students comprise an untapped pool of ideas which may have evaporated by the time they graduate or are stifled because on graduating they enter a narrow field; etc.

Yours, etc.,
J. J. LENAGHAN,
Vic. Branch.

Talks

THE PERFECT PASTURE FOR THE MEDITERRANEAN CLIMATE

The three following talks were given to a meeting of the Western Australian Branch in March 1960.

What the Animal Needs

By Dr. L. C. Snook, Animal Nutrition Officer, Department of Agriculture

A perfect pasture is one which will permit profitable land use while supporting all the stock as grazing animals all the year.

With such a pasture the need for management will be reduced to a minimum and the costs involved in the conservation, storage and feeding out of harvested material will be eliminated.

From the animal nutrition worker's point of view. The pasture must meet a series of criteria.

1. A perfect pasture must necessarily be acceptable and accessible to the grazing animal. For maximum production livestock must enjoy eating and must be able to obtain this enjoyment with the minimum of effort.

2. The pasture must have a high density per unit area, so that the animal can readily satisfy its needs. Density is here meant to imply the ability to provide the grazing animal with large mouthfuls of food in a restricted area. In other words the grazing animal should not be required to expend excessive time in collecting its food.

3. The water content of the pasture should not exceed 85 per cent. In many ways it is desirable that the maximum amount of water should be 80 per cent.

4. The pasture should at all stages retain a high degree of digestibility and ingestibility. This is perhaps the most difficult to satisfy in a Mediterranean climate. To be adequate for the summer months, pasture must be allowed to develop and mature during the periods which are optimal for growth—so there must be a decline in nutritive value and palatability. This deterioration is most marked in grasses but is also considerable in legumes.

Ingestibility is a word used to cover a complex of requisites. Not only must a fodder be palatable and readily digested but it must also be free of physical characteristics which will retard steady consumption or reasonably rapid passage through the gut.

5. The perfect pasture must supply adequate food all the year. Recent developments are showing that this ideal can be achieved in selected areas without subdivision, and where paddocks can be shut up to provide reserves there appears to be no limitation to the possibility of maintaining productive animals throughout the year as grazing animals. Continuous stocking with sheep at "Glen Lossie" at the rate of four wethers an acre has been shown to give maximum profit with minimum risk. At the Bramley Research Station it seems that stocking at the rate of one milking cow an acre can be achieved with continuous grazing in one paddock.

6. The edible material should never contain less than six per cent. crude protein. Adequate protein is essential for most forms of animals production and the criticism will be made that six per cent is not an adequate minimum. Here again we present the pasture people with a difficult requisite but it is one which can be achieved.

7. The pasture must be free of toxic principles. This seems an elementary necessity but the botanist is apt to say that most of the useful pasture plants are toxic in some form or another. It may be argued that it is the duty of the farmer to counter known toxic factors by management. But where do we draw the line.

The pasture must also be free of disagreeable physical features. Grass-seeds can cause costly losses among weaners, burr will reduce the value of wool, and taints can reduce the value of milk.

8. The perfect pasture must not be inadequate in essential minerals nor have unfavourable mineral ratios. The essential minerals which are present vary tremendously according to the species and to the stage of growth. Thus legumes may supply excessive calcium while cereals are certain to be deficient. Young pasture can be expected to supply ample phosphorus whereas mature herbage is almost certain to be deficient. Deep rooted plants such as lucerne will often supply adequate cobalt on soils where the shallower rooted annuals will induce wasting disease. A correct balance of minerals is likewise essential.

9. The ideal pasture must be able to resist ecological stresses. These can be particularly severe in a

mediterranean climate where all plants are likely to be subject to overgrazing at the break of the season. Perennials which endeavour to keep growing during the summer months are likewise vulnerable. Ability to resist attack from red mite and lucerne flea are additional essentials. In other words the pasture must be capable of withstanding our climate, our pests, and the most serious menace of all, our grazing animals.

10. The pasture must meet the specific requirements of the grazing animal. For example there must be adequate food for the pregnant and lactating ewe, the pasture must meet the needs of the lamb at weaning time, and it must be suitable for the production of standard milk. Here again, the pasture can put quite a lot of responsibility on the farmer's management. Obviously, the make-up of a perfect pasture will vary considerably according to the purpose for which the pasture is to be used.

No doubt my fellow speakers will be relieved to know that this concludes the list of requirements. The demands are not so unrealistic as at first they may appear. If we are prepared to admit that the ideal pasture for a Mediterranean climate must necessarily be a composite one and concede that the blend of species should be spread over a number of paddocks planted to make maximum use of available soil types, then we already have most, if not all, of the requisites for our needs.

Plants Available

By E. T. Bailey, Plant Introduction Officer, C.S.I.R.O.

Rather than a one plant pasture a mixed pasture would of course, be closest to the concept of the ideal pasture. This would contain plants with differing growing seasons, growth habits (above and below ground) and certainly differing periods of utilization. It would tend to become a series of patches, probably of one or two species, well adapted to the particular local conditions (even within a single farm). While this might satisfy the definition of supporting the grazing animal all the year, it would still be subject to big yearly variations in productivity.

Limited opportunities of developing this type of pasture leave us with the alternative of developing conventional pastures to support the animal as long as possible and supplementing these with areas of special plants for use at different periods.

"Sown Pasture" in Western Australia, generally means subterranean clover, Wimmera rye grass and a variety of weeds. In a few cases it may be certain perennials, and in much of the Wheat belt pasture may mean capeweed, silver grass and even cereal stubbles. For special summer feed over a fairly large area we see lupins grown as a self-regenerating pasture.

Surely, even with an extreme climate and soils, it is not logical to assume that sub-clover and weeds are all we can grow, nor that one variety Dwalganup is so well adapted that it is the only one that can be utilised—yet it covers 85 per cent. of the 6,500,000 acres sown to sub-clover in Western Australia.

I propose to mention some of the other plants, which merit attention more (in the case of legumes) than a shrug of the shoulders and the suggestion that we have sub-clover so what more could we need. But let me say that this will need either a re-orientation of man-power and money devoted to pasture research, or the finding of additional funds.

Legumes: Some attention has been paid to lucerne, with little success, possibly because we have expected strains developed for long growing seasons (from rainfall or irrigation) to thrive under our extreme climate conditions. We should be looking for drought-resistant, less productive strains. In view of the beneficial effects of small amounts of lucerne on animals grazing dry pasture, as demonstrated by Lloyd Davies, lucerne merits attention aimed at persistence and spread of production. White clover may also repay attention again to the Mediterranean summer dormant types rather than the high producing, irrigation varieties.

Strawberry and Red clover can be grown in limited areas and where adapted would be useful components of the pasture. So would some of the lotus species.

Even summer dormant strains give a more effective spread than annuals as they usually commence growth much more quickly at the beginning of the season and remain green equally as long as annuals at the end of the season.

The native *Kennedyas* deserve attention as perennial legumes for low rainfall areas. Some preliminary work has indicated problems to be expected and some possible results.

Rose clover, bladder clover, white woolly or cupped clover and helmer clover, (*T. dexvauxii, T. rerocephalum* and *T. pilurare*) are some possibilities where perennials are not likely to be economic success. So far, little is known about these except that they will grow and seed readily in dry areas.

With this group we can either let the plants out to farmers, who will show us their use and indicate

problems, or we can do much of the basic work before the species become widespread. Much material must be adequately tested with our present resources and it may be that as a result we are discarding useful plants.

Grasses: At present we have no perennial grasses in intensive use, but, with attention paid to strains and adaptability to soil types, we eventually will have. We have had little success with Phalaris, cocksfoot and perennial rye until recently, mainly because the only available strains were of European or New Zealand origin. We know that perennials can be grown in quite low rainfall areas but as yet we have no real knowledge of their production—so we are in no sound position to argue the merits of annuals against perennials.

Where annual pastures must be used, or few of the grasses warranting attention (on the evidence of production, seed production and persistence under periodic defoliation) are *Bromus mollis, B. carinatus, B. trinii* and *Lasio-chloa echinata*. General earliness of maturity is important in these annual grasses. As more is understood of requirements of both animal and plant I am sure that more material will become available.

Special purpose plants: These must be considered especially in the drier areas. Cereals for early pasture and summer feed must continue to play a part until our range of pasture species is extended. Lupins, peas and vetches are other special plants grown as crops but used as summer pastures, and must continue to be used to supplement pastures in some areas. Blue bush, tall wheat grass. *Paspalum vaginatum* and *Paccinellia* are promising plants for salt land. Others must exist, and intensification of search for them would produce results.

The browse plants are a group which plays an important part in providing green summer feed in the dry areas, and which has received almost no attention. They could provide a real answer to summer feeding problems. "Tree lucerne" is one which is crying for attention. Others which might be useful are shrubs such as *predicago arboren, Lupinus arboreus, Coronilla glauca, Adenocarpus spp.* and *Psoralea bitumenosa* to mention only a few.

The Environment

By E. N. Fitzpatrick, Research Officer, Department of Agriculture.

As you know, we have an intensely Mediterranean climate and a wide range of soils. In general, the more fertile soils are in the low rainfall areas, the poorer and less fertile soils in areas of high rainfall.

Coupled with an intensely Mediterranean distribution of rainfall we have high temperatures and low humidities in summer. Water might be considered to be our limiting factor in summer, and temperature and light interact to limit winter growth.

Only in late autumn and spring do temperature and moisture conditions combine to favour the growth of our present pasture species—so 50 per cent. of our dry matter is produced within six to eight weeks. Even at this time of the year growth is only rapid on soil of adequate fertility.

It has been suggested that 75 per cent. of our pasture never reaches the grazing animal. How can these conditions be modified? Our irrigation potential is almost fully developed and scope for water harvesting is limited—so we must direct our attention towards deeper-rooted species capable of utilizing winter moisture when conditions for growth become favourable. At present most of this winter moisture runs to waste because of low winter temperatures and the delay in establishment of present annual pastures. It may run into salty streams, into the salty water table, or form a perched water table to waterlog certain soils.

Increasing the winter growth of our present pasture species could be important, and serious thought could be given to use of nitrogen fertilizer to do this. An increase in production at this time of the year could give benefits in carrying capacity out of all proportion to the actual dry matter increase as a percentage of total dry matter.

Most of our soils are deficient in phosphate and nitrogen. Large tracts are low in calcium and sulphur and it is becoming recognised that an increasingly large area is low in potash, in many areas exceedingly low by world standards.

Onto this environment we have successfully grafted subterranean clover. By modifying the soil environment we have grown this shallow-rooted plant, with its high requirements for nutrients (as fertilizers) so successfully, that we spend a lot of time and money looking for small improvements when, if we look around we might find new and more satisfactory species.

For example, on our deep sands sub-clover will wilt in August, although there is adequate moisture four inches from the surface. Yet through depth these sands have an advantage in that they act as a vast moisture reservoir if we can get a plant with roots deep enough to extract this moisture. We have done enough work to know that lucerne and phalaris should be successful along the south coast; whether

they will be so on the western deep sands remains to be seen. If we can grow them, and they provide us with green feed when this is limiting, we can afford to modify the soil environment quite significantly even to the extent of using potassium fertilizers.

I suggest then, that the ideal pasture plant or plants should have a deep rooting system and so must be a perennial—should resist waterlogging, have low nutrient requirements, should be able to produce in summer, and have a root system well developed at the break of the season. It appears that this last quality could significantly conserve limited supplies of water and nutrients which otherwise are lost with the opening rains.

We are now looking for plants which can lengthen our growing season by a few weeks at either end, and have spent a great deal on perennials which might do this—and be a useful adjunct to present annual pastures. Perhaps if we looked around more we might find a plant or plants which could produce in the dry summer, which we have come to accept as a limiting factor in our pasture production.

The Riddle of the Sands

Mr. N. S. Tiver, Senior Agronomist, South Australian Department of Agriculture, in an address to the South Australian Branch.

When cleared, the deep podsolised sands of the south east of South Australia represented a potential erosion hazard because their successful development with pastures was until recently an unsolved riddle. Many people in the various research organizations contributed to the ultimate solution of this riddle.

In the South East leached sands ranging in depth from 3 feet to more than 30 feet extend over approximately 1 million acres. They are extremely infertile, and are characterised in the wetter areas by stringy-bark and heath and in the drier areas of the Upper South East by heath.

A brief outline was presented of the early experimental work carried out by the Waite Institute on the Wattle Range heathlands. The problem of pasture establishment on these areas later proved to be somewhat similar to the problem on the deep sands.

The main conclusions from this work were as follows:—

1. It was easier to establish pasture on degenerate pasture land which had a history of supering than on the virgin country.

2. In addition to superphosphate, potassium, copper and molybdenum were important for good pasture production.

3. Results with lime were variable. Its effect was confused by several factors, viz., induced zinc deficiency, stage of development i.e. degenerate pasture compared with virgin heath and quantity of superphosphate applied.

4. On the virgin heathland the problem of poor legume establishment was due to defective nodulation which resulted in a high seedling mortality.

On the deep sands, a similar problem was investigated by the Department of Agriculture. Many preliminary trials were conducted before it was discovered that relatively small quantities of lime (2 cwt per acre) drilled in with the pasture seed greatly assisted establishment. An analysis of the lime response revealed that lime improved germination, nodulation and plant yield.

Superphosphate at 187 lb per acre substantially depressed the germination of subterranean clover, lucerne and phalaris. By using an equal quantity of lime mixed with the superphosphate this depressing effect of super could be eliminated.

On acid soils of low base status the most widespread effect of lime in pasture establishment in southern Australia was to correct defective nodulation. It accomplished this in one or more of several ways, either by correcting the pH of super, correcting soil pH, or by supplying calcium.

In South Australia on the deep sands with a pH 5.5 to 6.5 and exchangeable calcium of 1 to 2 m.e. per cent., the evidence suggested that calcium was more important than pH in overcoming the nodulation problem.

In addition to its effects on germination of all species and nodulation of the legumes, lime also improved the yield of individual plants of phalaris in a pure stand without legumes. In view of this, it was considered likely that some of the increased production of lucerne and subterranean clover as a result of using lime was due to the direct effect of calcium on plant nutrition. Heavier rates of lime of 2 bags per acre gave increased yields of lucerne and subterranean clover.

As far as pasture species were concerned the most suitable were deep rooting plants like lucerne and phalaris which were best adapted to utilise both the moisture and fertility reserves of deep sands. Lucerne needed to be inoculated for best results. Subterranean clover was regarded as secondary legume and where it was included in the initial sowing,

seeding rates were kept down to 1 lb per acre, otherwise the survival of lucerne over the first summer could be jeopardised in a dry season. No responses to inoculation of subterranean clover were obtained.

The recommended method of establishing pastures on the deep sands was to drill in the pasture seed with 187 lb of lime per acre and apply the superphosphate, copper, zinc and molybdenum as a separate top dressing operation. This was done to avoid bringing inoculated seed into contact with the superphosphate, copper and zinc. The position regarding potassium was still uncertain, but it was hoped that regular applications might not be necessary where deep rooting plants like lucerne and phalaris were being used.

ANIMAL PRODUCTION

Journal of the British Society of Animal Production

Contents of Volume 2, Part 2, September, 1960.

CRICHTON, AITKEN and BOYNE. The effect of plane of nutrition during rearing on growth, production, reproduction and health of dairy cattle. III. Milk, butterfat and solids-non-fat production during the first three lactations with associated live weight changes, and feed costs to first calving.

HOLMES and OSMAN. The feed intake of grazing cattle. I. Feed intake of dairy cows on strip and free grazing.

WIENER. Factors influencing average milk yield of herds at two levels of production.

BARBER, BRAUDE, HOSKING and MITCHELL. Studies on liquid skim milk for growing pigs. The effect of its abrupt removal from the diet and of supplementation with copper sulphate or amino acids.

ROBERTSON, O'CONNOR and EDWARDS. Progeny testing dairy bulls at different management levels.

PRESTON, NDUMBE, WHITELAW and CHARLESON. The effect of partial replacement of groundnut meal by white-fish meal in the diet of early-weaned calves.

LAMMING, STOKES and HORSPOOL. The influence in growth rate and slaughter characteristics of implanting fattening male hoggets with various levels of hexoestrol and diethylstilboestrol.

GATHERUM, HARRINGTON and POMEROY. Preliminary studies of eye judgments of the gammons of bacon pigs in relation to dissection data.

ARNOLD. Harness for the total collection of faeces from grazing ewe and wether sheep.

HODGES, O'CONNOR and CLARK. The size of dairy heifers.

OSINSKA and KIELANOWSKI. Relationship between meat colour and feed efficiency in pigs.

This journal is a continuation and expansion of the **Proceedings of the British Society of Animal Production** (1944-58), and has appeared in volumes of two parts but in order to make provision for the increasing flow of material submitted for publication **it will in future, commencing with Volumes 3 (1961), appear in annual volumes of three parts** in February, June and October. **The annual subscription will be 45s. ($7.50 in U.S.A. and Canada),** single parts 17s. 6d ($2.75 in U.S.A. and Canada) net. Orders and subscriptions should be sent to:—

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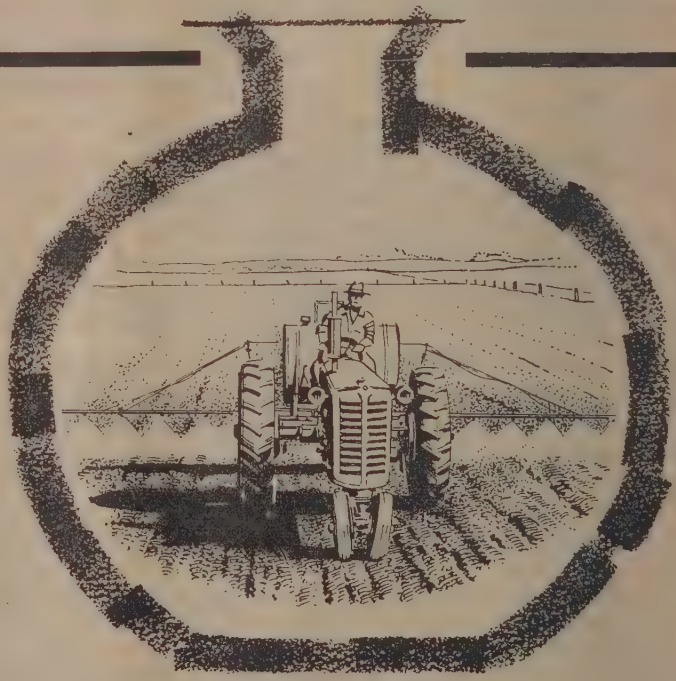

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News Items

The New Journal

The Australian Journal of Experimental Agriculture and Animal Husbandry is to be produced and published by The Australian Institute of Agricultural Science on behalf of The Australian Agricultural Council.

The Journal will publish the results of original research in any field that has a direct bearing on the problems of crop, pasture, and animal production in Australia and its dependencies. It will publish full research papers and short communications.

The Journal is controlled by a committee of management comprised of Mr. W. A. Ives and Mr. F. M. Read, representing the Standing Committee on Agriculture, and Mr. R. G. Downes and Mr. A. J. Vasey, representing the Australian Institute of Agricultural Science.

Acceptance of papers is the responsibility of an Editorial Advisory Committee appointed by the Committee of Management. The members of the Advisory Committee are—Mr. R. G. Downes, (Chairman), Mr. R. N. Sandiford (Editor), Mr. C. E. Cole, Mr. S. Fish, Mr. C. J. R. Gorrie, Mr. W. B. Miller and Mr. A. J. Vasey.

A Guide to Authors is in preparation. In the meantime, Notes on the requirements and types of suitable papers are available from the editor.

All enquiries, correspondence and manuscripts should be addressed to:—

The Editor,
Australian Journal of Experimental Agriculture and Animal Husbandry,
226 Clarendon Street,
East Melbourne, C.2., Victoria.
Phone: JA 6377.

Professor Sir Robert Dickie Watt

The recent Queen's Birthday Honours included a Knighthood to Emeritus Professor Robert Dickie Watt, in recognition of his outstanding service to Australian agriculture.

Sir Robert was founder of the first University School of Agriculture in Australia in 1910, and occupied the Chair of Agriculture in Sydney for 37 years and the Deanship for 26 years. On retirement he was awarded the honorary title of Emeritus Professor for long and distinguished service.

Professor Watt was chairman of the N.S.W. State Committee of C.S.I.R.O. for 20 years and was twice a member of the Sydney University Senate. His service to science and agriculture may be gauged from his honorary life membership of A.I.A.S., the Royal Society of N.S.W. and the R.A.S. of N.S.W.

Sydney Faculty's Fiftieth Anniversary

The Faculty of Agriculture, Sydney University is celebrating its fiftieth anniversary this year which is also the twenty-fifth anniversary of the Institute. Celebrations will be held in August and September; there will be a three day exhibition of agricultural topics at the School of Agriculture and an Oration in the Great Hall. Graduates and their wives will celebrate at a chicken barbecue. To mark the occasion, the Institute has undertaken the raising of £2,500 to endow an annual scholarship at the end of the third year. Publicity has been arranged through the A.B.C. and the rural press and a supplement to the Sydney Morning Herald, on the double jubilee will be published.

The Ian Clunies Ross Animal Research Laboratory

On March 9 the C.S.I.R.O., Sheep Biology Laboratory at Prospect in New South Wales was officially opened by Lord Casey and was renamed the Ian Clunies Ross Animal Research Laboratory, in honour of the late Chairman of C.S.I.R.O. who did so much to encourage fundamental biological research, for which this laboratory was established.

Lectures for Farmers

In May the Schools of Wool Technology, Civil Engineering and Mechanical Engineering of the University of New South Wales, held a five day session of lectures and practical demonstrations for farmers and graziers. General topics were sheep and wool improvements, agricultural engineering and soil and water engineering. Twenty-four of Sydney's well-known authorities delivered the lectures. About 100 attended.

Australian Society of Plant Physiologists

The second meeting of the Australian Society of Plant Physiologists was held in Canberra from January 13 to 15, 1960.

At the Annual General Meeting it was announced that following the untimely death of the President, the late Professor J. G. Wood, the Committee had appointed Dr. R. N. Robertson to the position of President. The Obituary to Professor Wood delivered by Professor Turner before the opening session of the Conference expressed the sad loss that the Society had suffered.

At the annual business session, it was decided to compile a register of the Society's members and to make this available to oversea organizations. It was also agreed that the Australian Society would support the International Association for Plant Physiology. Finally it was agreed that the next meeting of the Society would be held in Brisbane during May 1961.

The sessions for presentation of scientific papers comprised five groups which occupied half a day each. These sessions were entitled: Physical Plant Processes, Chairman, Professor J. S. Turner; Plant Development, Chairman Dr. D. J. Carr; Nitrogen Metabolism, Chairman Dr. D. Spencer; Carbohydrate Translocation and Metabolism, Chairman Dr. L. H. May; Growth Regulators, Chairman Dr. N. P. Kefford. In all, 27 papers were presented and each evoked vigorous discussion. Abstracts of all papers will be published shortly in the Australian Journal of Science. One afternoon was set aside for a discussion, under the leadership of Dr. L. T. Evans, on the construction and use of the proposed Canberra Phytotron. A prototype glasshouse and cabinets were available for inspection.

C.S.R. Phytotron

To conduct basic research into the processes by which the sugar cane plant produces and stores sugar, The Colonial Sugar Refining Co. Ltd. will build a plant research centre, called a Phytotron, at Brisbane at a cost of about £300,000. The centre will cost about £40,000 a year to run.

The main feature of the Phytotron would be a series of laboratory green-houses in which any natural growing conditions could be artificially reproduced. It would thus be possible to study the behaviour of the cane in any desired circumstances of temperature, wind, humidity and light.

Conditions in some of the rooms of the Phytotron will be controlled to such a degree that to avoid contamination by insects and micro-organisms staff working on the project and visitors will be required to wash and change before entering.

This will be the first Phytotron in the world devoted solely to sugar cane, and also the first devoted to any single crop. It is expected to be in operation next year.

The scientist in charge of the centre will be Dr. K. T. Glasziou.

The research centre, which will be situated near Indooroopilly golf course, will be named the David North Plant Research Centre to commemorate pioneering research by Mr. D. S. North, a retired officer of C.S.R.

Translations of Russian Journals

The American Institute of Biological Sciences is currently translating and publishing seven Russian research journals in biology. These journals are translated with support from the National Science Foundation, which is eager that such information be more widely distributed to biologists throughout the world. It is hoped that this material will aid biologists in research, prevent duplication of work, give some idea of the work being done by Soviet scientists in the field of biology, and also bring about a better international understanding among scientists.

Because of the support of the National Science Foundation, the AIBS can offer these translations at a fraction of their publication cost, with even further price reduction to AIBS members and to academic and non-profit libraries. This reduction, the AIBS feels, places the translation within the reach of all biologists.

The journals currently being translated are: Doklady: Biological Sciences Section; Doklady: Botanical Sciences Section; Doklady: Biochemistry Section; Plant Physiology; Microbiology; Soviet Soil Science; and Entomological Review.

In addition to its program of Russian Biological Journal translations, the AIBS has instituted a separate program of translation and publication of selected Russian Monographs in biology.

It was felt that the program of Journal translations were not sufficient to cover all of the significant work being done in all fields of biology by Russian scientists. With the aid of competent authorities, the AIBS has translated and published six Russian monographs and one monograph is in the process of being

published. In addition, several prominent monographs in various biological areas are being considered by the AIBS and the National Science Foundation for translation and publication. The monographs that have been published are: Origins of Angiospermous Plants by A. L. Takhtajan; Problems in the Classification of Antagonists of Actinomycetes by G. F. Gauze; Marine Biology by Trudi Institute of Oceanology, Vol. XX, edited by B. N. Nikitin; Arachnoidea by A. A. Zakhvatkin; and Arachnida by B. I. Pomerantzev. The manuscript for plants and X-rays by L. P. Breslavets is in the final stages of preparation and should be published early in 1960.

Additional information pertaining to this program may be obtained by writing to the American Institute of Biological Sciences, 2000 P Street, N. W., Washington 6, D.C., U.S.A.

Potash Usage

The following figures show the combined tonnages of muriate and sulphate of potash used in the calendar years 1957 to 1959:—

	1957	1958	1959
Fruit (temperate)	5238	5120	5424
Fruit (tropical)	3407	4357	3742
Vegetables	3551	3660	4247
Potatoes	3577	3785	3524
Sugar Cane	12539	13780	12293
Tobacco	582	1234	1599
Pastures	9368	11431	14356
Home Gardens	344	446	638
Other Crops	676	510	608
Industrial	358	234	481
Total	39640	44557	46912

The sulphate share of Australia's potash consumption continued to increase during 1959 and amounted to 13.2 per cent. of the total usage.

Pastures, particularly in Victoria, were the dominant potash users in 1959, displacing sugar cane for the first time.

Tonnages of potash fertilisers used in each State during 1959 were:— Queensland 18,857; Victoria 14,042; Western Australia 5,449; Tasmania 3,543; New South Wales 3,349.

Enrolments in Agricultural Science Courses, 1960

University	*Year of course* 1.	2.	3.	4.	*Completed course in* 1959
Adelaide	36	18	13	13	14
Melbourne	68	44	60	43	38
Queensland	58	48	26	31	19
Sydney	62	40	48	48	43 (and 3 B.Agr.)
Tasmania	9	5	—	—	—
West. Aust.	38	16	11	14	11
TOTALS:	271	166	158	149	126 (and 3)
ASSOCIATED COURSES:					
Wool Technology (N.S.W.)	17	9	3	4	2
Rural Science (New England)	51	26	21	11	9
Agricultural Economics (New England)	11	9	6	—	—
Agricultural Engineering (Melbourne)	—	—	1	2	2

Breeding work in Queensland

A symposium on the breeding of *Leucaena glauca* and *Sorghum almum* was held by research workers at the Cunningham Laboratory on July 1. Mr. S. G. Gray pointed out that *L. glauca* could become quite important in the future in areas receiving 30 in. of rainfall or more and where frosts are not repeated or severe. Around 3½ thousand pounds of protein per acre have been obtained with the best strains at Samford. In his breeding and genetical work he is aiming at high yields in conjunction with multiple branching, giving a bush-like habit more adaptable to grazing. In his work with *Sorghum almum, Mr. A. J. Pritchard* is aiming at high yielding, frost tolerant types with a distinctive seed. One of the problems is the development of strains adapted to a latitudinal range from Goondiwindi to Collinsville.

Soya Beans in Queensland

Considerable interest is being shown in the development of soya beans as a crop for the black soils of Queensland and the work Mr. D. E. Blyth of the Cunningham Laboratory has been doing has indicated that high yielding types can be developed

for these conditions. In the 1959 season at the Cooper Laboratory, Lawes, the best of Mr. Blyth's strains reached a yield of 1800 lb of seed per acre, and this year, with practically no rainfall over the growing season, the best strains have yielded 1000 lb per acre. In all the experiments the beans have been sown at the end of January to gain the maximum benefit from the monsoonal rains.

Queensland University News

Present enrolments in the Faculty of Agriculture are:—

1st year—58 2nd year—48
3rd year—26 4th year—31

Fourth year students have specialised as follows:—
Agricultural Economics—2
Agronomy—14
Agrostology—6
Animal Nutrition—3
Plant Pathology—3
Plant Physiology—3

Nineteen students graduated in 1959.

There are now 5 Colombo Plan post-graduate students in the Department of Agriculture at the University. The students and their interests are: *Mr. T. K. Achari*—Farm management; *Mr. P. K. Khedekar*—Soil moisture; *Mr. J. Kotalawala*—Phosphorus nutrition of tomatoes; *Mr. G. K. Patwadhan*—Sugarcane agronomy and *Mr. H. K. Thaung*—Agronomy.

Scholarships awarded to Honour students in the University Department of Agriculture are the Ivor A. Gill Memorial Scholarship to *D. R. Laing* (Agronomy) and the Edwin Munro and Robert Philp Scholarship to *P. C. Whiteman* (Plant Physiology).

Fourth year Agriculture Students under *Dr. P. J. Skerman* made a two day trip to the Kingaroy and Gayndah Districts on March 30-31, 1960 to inspect the peanut industry and the Department of Agriculture and Stock's Station at Brian Pastures. On May 27, the students left for a 16 day tour of the north (to Cairns) and west (to Winton) of Queensland. Drs. P. J. Skerman and O. McCarthy and Mr. W. E. Fox will accompany the students on the trip.

The Wheat Industry Research Committee has granted £1,600 to the University Department of Agriculture for continuation of *Mr. F. From's* work on uptake and distribution of nitrogen in wheat plants.

The glasshouse donated to the University's Faculty of Agriculture from the Tooth Bequest is now under construction at St. Lucia. The University has given approval also for the construction of a further glasshouse this year and another next year.

W.A. Department of Agriculture's New Buildings

The West Australian Department of Agriculture's building programme is approaching completion. Members of the Animal Division have moved into their new quarters, and the last of the four South Perth buildings, the administrative block, is well under way. This is expected to be completed by the end of the year.

Federal President for 1960

Mr. A. L. Tisdall

Mr. A. L. Tisdall, Commissioner of the State Rivers and Water Supply Commission of Victoria, is the Federal President of the Australian Institute of Agricultural Science for 1960.

Mr. Tisdall graduated in Agricultural Science from the University of Melbourne in 1932. In 1933 he joined the staff of the C.S.I.R. research station at Merbein. In 1935 he was seconded to the Waite Institute to carry out research in the soil physics of irrigation. His work in this field was continued at Merbein and, in 1937, was the subject of his Master's Thesis.

Mr. Tisdall served as a navigator with the R.A.A.F. from 1942 to 1945.

On return to civilian life he was selected by the C.S.I.R.O. to plan, develop and direct a new Regional Pastoral Laboratory at Deniliquin in New South Wales. While at Deniliquin he directed research in irrigation problems of pasture and fodder crops.

In 1951 Mr. Tisdall joined the State Rivers and Water Supply Commission of Victoria, as Chief Irrigation Officer. In the same year he visited the western states of U.S.A. to study irrigation and drainage problems and practice. He was appointed Commissioner in 1957.

A foundation member of the Institute, Mr. Tisdall was President of the Victorian Branch in 1955.

Personal Notes

Australian Capital Territory

Dr. B. T. Dickson was awarded a C.M.G. in the recent Birthday Honours "in recognition of outstanding public service". Dr. Dickson, who was President of our Institute 1945-46, was first Chief of the Division of Plant Industry 1927-51, and has been Chairman of Canberra University College Council since 1954.

O. H. Frankel, A.C.T. Branch President, left Australia on June 28, for U.S.A. where he will visit Corvallis, Oregon, en route to England. There he will take part in the Fiftieth Jubilee of the John Innes Horticultural Institution and attend the first part of the International Grasslands Congress. Later he will attend the Tercentenary Celebrations of the Royal Society.

A. V. Blackmore spent a brief period in Canberra on his return from Cornell University, New York, U.S.A., where he gained a Doctorate of Philosophy for his thesis: "Swelling clays as related to exchange cations". He will be located at Adelaide for a year with Division of Soils before taking up duties at Perth Regional Laboratory as Regional Physicist. He will be mainly concerned with the hydrological conditions of Western Australian soils.

F. H. Bolman left on August 2 for California where he has a Research Assistantship for two years (plus Fulbright) at Berkeley campus of University of California. He will engage in graduate studies in advanced agricultural economics concerned with land resources and irrigation.

S. M. Bromfield leaves in August to spend twelve months at the Macauley Institute, Aberdeen.

B. E. Butler has gone on a round the world trip for six months on long service leave. He flew to Greece and planned to take in as much of Europe and the United States as he could.

D. O. Norris is to be congratulated on the award of the Australian Medal of Agricultural Science for 1960 for his work on plant viruses and rhizobium research in legumes.

R. A. Perry left in August for 12 months at Tucson, Arizona, where he will study range management research.

W. M. Willoughby is on a six months overseas study tour during which he will attend the International Grasslands Congress. On his return he will go to Armidale as Officer-in-Charge of the regional laboratory of the Division of Animal Physiology.

New South Wales

Associate Professor J. M. Vincent—has returned from sabbatical leave overseas. He worked at Rothamsted for six months and visited laboratories and institutions in Scotland, Scandinavia, Holland and Denmark where he spent some time with Jensen. He also attended the Agronomy Conference in Cincinnati, U.S.A. and then returned to Europe to spend a few weeks with the soil microbiology group at the Pasteur Institute.

Professor T. J. Robinson—is again overseas, this time in Indonesia, at Bogor, where he is lecturing to local veterinarians and animal husbandrymen on beef and dairy cattle production.

Overseas visitor—Mr. H. Faille—who is Senior Lecturer in the Department of Agricultural Engineering, University of Durham is visiting Australia under the auspices of the Vice Chancellors' committee. Mr. Faille is responsible for the only course on agricultural engineering in the United Kingdom.

Dr. O. Carter—has returned to Australia after four years' absence in the U.S.A. He obtained his Master's degree and Ph.D. in the Agronomy Department at Cornell where he worked on soil fertility problems, initially on a Rotary Scholarship and then on a research assistantship. Dr. Carter is now lecturing in Agronomy at the University of Sydney.

Mr. C. K. Vears—principal agronomist (pastures) with the N.S.W. Department, represented his department at the 8th International Grasslands Congress at Reading in July. He also visited South Africa, to see research work on the management of native pastures, and U.S.A. to see latest trends in pasture seed production.

Mr. C. J. King, Chief of the Division of Marketing and Economics of the N.S.W. Department, recently studied meat industry problems in North America with a group of representatives of the Australian Meat Industry, and graziers. He also visited Germany and Italy on behalf of the Egg Marketing Board of N.S.W.

Dr. C. J. Magee, Chief of the Division of Science Services of the N.S.W. Department is attending the 6th Commonwealth Mycological Conference and the Commonwealth Agricultural Bureau Conference in London; he is presenting papers by staff of the biological Branch and will be away for a total of four months.

Professor P. R. McMahon attended the International Textile Conference at Harrogate in the U.K. and visited Russia, the continent and U.S.A. before returning.

Mr. R. B. Whan a recent graduate of the School of Wool Technology, is on two years leave from the Bureau of Agricultural Economics. He will study the importance of crimp on wool quality, under Professor Speakman at Leeds.

Mr. C. A. Graham —who is a technical officer with the University of N.S.W. leaves in September to take up a Research Assistantship in Animal Husbandry at the University of Wyoming.

Northern New South Wales—Sub Branch

Dr. D. R. Lamond, lecturer in Livestock Husbandry, Faculty of Rural Science, University of New England, has been awarded Ph.D. (Sydney) for his thesis entitled Studies of Pituitary-Gonad Relationships in the Albino Mouse.

Miss Bridget Ogilvie, the first woman graduate from the Faculty of Rural Science, University of New England, has commenced duties as a demonstrator in the Department of Nutrition, Faculty of Rural Science. Miss Ogilvie was awarded the Dean's prize and University Medal.

Victoria

Mr. R. L. Twentyman—Senior Agrostologist, Department of Agriculture attended the International Grassland Congress at Reading, England, in July. He was also present at the British Grassland Society Summer Conference at Harrogate and visited Grassland research centres in the U.K. and on the continent.

Mr. R. N. Sandiford has resigned from the Department of Agriculture, to take up the position of Editor of the new *Australian Journal of Experimental Agriculture and Animal Husbandry.*

Mr. W. Stanhope—Poultry Research Officer, Department of Agriculture, returned from a visit to the U.S.A. and U.K., where he studied recent developments in the poultry industry.

Mr. J. P. Makeham has resigned from the Department of Agriculture and has commenced a private consulting service in the Colac area.

Mr. D. Mentz has resigned from the Department of Agriculture to take a position with the Agriculture Branch of the Northern Territory Administration at Darwin.

Mr. P. Baxter—Horticultural Research Officer, Department of Agriculture, is at present studying at the University of Bonn, West Germany, under the auspices of a Humboldt fellowship.

Mr. A. Lee has resigned from British Farm Equipment, to take up farming at Charlton, Victoria.

Mr. A. B. Cashmore has been appointed Professional assistant to the Professor of Agriculture, University of Melbourne.

Mr. W. P. Dunk, Senior Irrigation Officer, State Rivers and Water Supply Commission, returned from a three months period overseas in July. He visited the U.S.A. and U.K. and attended the International Irrigation Conference in Madrid.

Mr. M. Savidge, Henry York & Co., also returned recently from overseas. He visited U.K., U.S.A. and Europe, to study fertilizer usage, in particular nitrogen fertilizers.

Mr. B. Hart has transferred from the Department of Agriculture to the Vermin and Noxious Weeds Section of the Lands Department.

Queensland

Mr. R. Bray who graduated from the Agriculture Faculty last year left this month for the University of Wisconsin where he will take the Ph.D. Course in plant genetics. He has been working since taking his finals at the C.S.I.R.O. Division of Tropical Pastures at St. Lucia.

Dr. P. J. Skerman commences Sabbatical Leave in December this year. He has been granted an Oil Industries' Bursary to report on methods of improvement of the beef cattle and sheep industry of Kenya. Following this Dr. Skerman will visit India, the United Kingdom, and finally the United States where he will spend 4½ months on a Carnegie Grant.

A conference on the *Technological Use of Radiation* was held at the University of New South Wales, Kensington from May 23-25. The object of the Conference was to review recent developments and to stimulate research and interest in the technological applications of radiation. Sessions covered dosimetry, experimental and commercial plant design,

food preservation, sterilisation of industrial raw materials, insect pest control, and genetic applications including plant improvement. Dept. of Agriculture representative was *Dr. B. R. Champ.* Following the conference *Dr. P. B. Cornwell* of the U.K.A.E.A. and *Dr. J. G. Clouston* of the A.A.E.C. visited Queensland in connection with a survey of possible applications in disinfestation of stored products.

Dr. E. M. Hutton visited the Grafton and Wollongbar Experiment Stations of the N.S.W. Department of Agriculture and inspected the work on summer legumes for the north coast dairy industry. After these visits, Dr. Hutton addressed the annual convention of the Tweed Richmond Agricultural Bureau at Casino on "Pasture legumes for the sub-tropics".

Dr. David Riceman an Institute medallist from the C.S.I.R.O. Division of Biochemistry and General Nutrition in Adelaide visited the Cunningham Laboratory from April 4-12. Another recent visitor to the Cunningham Laboratory has been *Mr. K. Wilson Jones,* Officer-in-Charge of the C.S.I.R.O. coastal Plain Research Station near Darwin.

The Liaison Tour for Industry Representatives from April 5-8 took in the Cunningham Laboratory, C.S.I.R.O. Cannon Hill, C.S.I.R.O. Animal Health and Department of Agriculture and Stock at Yeerongpilly, and C.S.I.R.O. Pasture Research Stations at Beerwah and Samford. The tour was organized by Dr. Don Williams and Mr. Ron Churchward of the C.S.I.R.O. Agricultural Research Liaison Section in Melbourne, and the primary object was to acquaint industry with the work of C.S.I.R.O. Brisbane.

When the Federal Parliamentary Agricultural Committee visited the Cunningham Laboratory on Saturday, June 25, *Mr. W. W. Bryan* was able to report to them that the legume problem on the Wallum had been solved with such species as *Lotononis bainesii, Desmodium uncinatum,* and white clover. This has been achieved after about 10 years' work, and the grass-legume pastures now developed will carry ¾ of a beast per acre.

Many Institute members took advantage of the invitation of the Entomological Society of Queensland to hear an address, "Races and Species in *Drosophila paulistorum*" by *Prof. Th. Dobzhansky* of the Zoology Dept., Columbia University, New York, who is spending a year in Australia at the Zoology Department, University of Sydney, on a Guggenheim Fellowship. The address was given in the Zoology Lecture Theatre on Tuesday, May 17.

South Australia

Mr. N. S. Tiver, Senior Agronomist, Department of Agriculture, delivered a paper at the Eighth International Grassland Congress at Reading, England. After a further three months in the United Kingdom and Europe inspecting land reclamation and development he will take up a Harkness Fellowship for a year of study and travel in the United States. Nine months of this will be spent at Davis, California, where he will look at irrigation as applied to pastures and fodder crops.

Mr. H. J. Lee, Division of Biochemistry and General Nutrition, C.S.I.R.O., has returned from an F.A.O. assignment carried out at the Instituto Biologico at Sao Paulo in Brazil to give guidance and assistance in setting up and conducting a survey of trace element deficiencies affecting livestock.

Dr. R. J. Best, Reader in Virology at the Waite Institute, is back from a year's study leave which he spent in the British Isles, Europe and America. He was at the Agricultural College, Wageningen, Holland for two months as Visiting Professor and he delivered a paper at the International Botanical Congress at Montreal last year.

Professor C. M. Donald recently returned after a year abroad studying techniques in agronomic research and student training. After having six weeks in Ceylon, he went to England and the Continent and spent six months in the United States where he visited Davis and Cornell Universities.

Mr. R. I. Herriot has been appointed Deputy Director of the Department of Agriculture. He will retain his position as Chief of the Division of Extension and Information.

Mr. H. T. Hughes of Prospect Hill, near Meadows has become South Australia's first private Agricultural Consultant. He runs a sheep and cattle property and will be available to give advice privately, on farming problems.

Mr. R. Scott-Young, who recently completed his Honours B.Ag.Sc. degree in the Agronomy Department, Waite Institute, took up an appointment in Melbourne with the Development Division of Shell Chemicals (Aust.) Pty. Ltd. late in April. He has just returned from a tour of New Zealand.

Mr. M. S. Buttrose, who is now studying in Switzerland, has accepted a Post Doctorate Fellowship in the Plant Physiology Department, Waite Institute. The Fellowship is financed from the Wheat Industry Research Council and his studies will be on the structure of starch granules.

Mr. J. V. Mertin attended the second Agricultural and Veterinary Chemicals Convention held in Sydney

in April. He was elected Federal President of the Agricultural and Veterinary Chemicals Association of Australia and is also President of the South Australian Division of this Association.

Mr. A. J. K. Walker, formerly Chief Agricultural Advisor, was recently appointed Chief of the Division of Plant Industry in the Department of Agriculture.

Mr. D. C. Swan, Entomology Department, Waite Institute, is visiting Honolulu, the United States and Canada, on study leave assisted by a grant from the Rockefeller Foundation. In August, he will attend the 11th International Entomological Congress in Vienna. He will then visit England where time will be spent at Rothamsted and Cambridge. He expects to return to Adelaide in February next year.

Mr. A. J. Brink formerly a technical officer in I.C.I. has recently taken up a position with Dow International, a subsidiary of the Dow Chemical Corporation, as sales manager for South East Asia and Australasia. He will take up his appointment shortly in Hongkong.

Mr. E. D. Carter, Senior Research Officer, Division of Plant Industry, South Australian Department of Agriculture, has accepted an appointment as Lecturer in the Department of Agronomy. He will be working on pasture management and is expected to take up his duties in August.

Mr. Stuart Hawkins, who is returning from the Argentine, is attending the Eighth International Grasslands Congress at Reading.

Mr. K. P. Barley, Agronomy Department, Waite Institute, has been granted leave for 9 months to work at the Department of Soil at the University of California, Berkeley. He will leave Adelaide in November.

Professor C. M. Donald, Agronomy Department, Waite Institute, has been appointed a member of the Advisory Council of C.S.I.R.O.

Dr. C. G. Stephens will leave in August to attend the International Society for Soil Science Congress in Madison, U.S.A. He expects to be away for 3 months, and will return through Europe and India.

Western Australia

West Australians at the International Grasslands Congress at Reading, England, this year will be *Mr. G. H. Burvill, Professor E. J. Underwood* and *Dr. A. J. Millington.* Mr. Burvill's attendance will coincide with his trip to England and the Continent, during which he will also visit a number of agricultural research institutions.

Mr. A. Holland, late of the W.A. Department of Agriculture, has joined the Microbiology section of the Institute to work on rhizosphere relationships in subterranean clover.

Mr. C. Asher, who recently completed his term with the Papua-New Guinea Service, has been awarded a Wool Research Fellowship to investigate factors influencing potassium uptake in pasture plants.

Dr. E. G. Hallsworth has taken up the position of Visiting Professor of Soil Science at the Institute of Agriculture. Professor Hallsworth was Professor of Agriculture at Nottingham.

Mr. G. R. Pearce, a W.A. graduate who until recently worked at the Werribee Animal Husbandry Research Centre, is now working towards a Ph.D. at the Institute of Agriculture. His field is pasture utilisation by ruminants.

Mr. F. Roberts has finished his work for a Ph.D. and has joined the C.S.I.R.O. Division of Plant Industry, where he will carry out research into soil-water relationships.

Mr. W. P. Cass-Smith, Superintendent of the Biological Services Division and *Mr. L. W. Shier,* Superintendent of Wheat Farming, attended a Root Rot conference at Wagga, N.S.W. recently.

Dr. J. S. Gladstones has returned from Canada, where he held a Canadian National Research Council post-doctorate fellowship, studying radiation genetics in tomatoes. He will continue his research on lupins at the University Institute of Agriculture.

Dr. E. Greenwood has joined the CSIRO Division of Plant Industry to work on Nitrogen nutrition of pasture plants. Dr. Greenwood formerly worked with Professor E. G. Hallsworth at the University of Nottingham.

Dr. M. Somers is in America, carrying out research at the Department of Animal Science of the Ohio Agricultural Experiment Station.

Mr. N. Shorter has returned to the Horticulture Branch of the Department of Agriculture, after working for some time in Victoria.

Mr. G. R. Hale will spend another year at the University of California, where he hopes to complete his Ph.D. He is on leave from the Plant Research Division of the Department of Agriculture.

Mr. R. Morgan, a Melbourne graduate, is now at the Institute of Agriculture, University of W.A., working towards a master's degree in agricultural economics.

Mr. G. Taylor, formerly of the Victorian Department of Agriculture has joined CSIRO as an Experimental Officer in Perth.

Professor E. J. Underwood returned this month from an overseas tour of three months during which he attended the Tercentenary celebrations of the Royal Society in London; the 8th International Grasslands Congress at Reading; the 6th International Congress of Soil Science at Madison, Wisconsin, U.S.A.; the 5th International Nutrition Congress at Washington, and presented the first series of Babcock Lectures at the University of Wisconsin.

Mr. A. Beck, who recently transferred from the Animal Health Division to Plant Industry Division of CSIRO, will spend some months in Brazil on a technical assistance assignment before moving to his new position.

Dr. D. P. Drover, Senior Lecturer in Soil Science at the University of W.A. will leave in November this year to take up the position of Professor, and Head of the Department of Soil Chemistry at the University of Khartoum, Republic of Sudan.

Mr. J. Langdon has transferred from the Irrigation Branch to the Dairying Division of the Department of Agriculture. He is stationed at Harvey.

Mr. D. Leeuwrick, formerly a plant breeder in the Department of Agriculture, has joined the Shell Chemical Company.

Messrs. G. R. W. Meadly and G. A. Pearce, of the Department of Agriculture, attended the Australian Weed Control Conference in Canberra in August.

Mr. B. Marsh resigned from the Soils Division of the Department of Agriculture in June to become Agricultural Officer at Norfolk Island.

Mr. J. McMullen, formerly Soil Conservation Adviser at Geraldton, has transferred to the Wheat and Sheep Division, and is doing plant breeding work in Perth.

Tasmania

Mr. L. R. Ward, formerly President of the Tasmanian Branch, has left the Tasmanian Department of Agriculture to take up a position with Henry York & Co., with headquarters in Melbourne.

Following Mr. Ward's resignation, the former Vice-President, *Mr. S. M. Sykes,* has been appointed President of the Branch.

Mr. J. F. Burdett has resigned from the Plant Pathology Division to take up a research studentship at the Waite Institute. Mr. Burdett was working on problems of nematology in Tasmania and is continuing studies in the field of nematology at the Waite Institute.

Mr. B. Thistlethwayte has transferred from the Horticultural Division to the Plant Pathology Division and is continuing the work initiated by Mr. Burdett.

Mr. B. C. Jeffries, formerly a member of the South Australian Branch, has transferred to the Tasmanian Branch upon taking up the position of Senior Sheep and Wool Officer with the Tasmanian Department of Agriculture.

Mr. E. F. Fricke, Chief Agronomist of the Tasmanian Department of Agriculture, has recently attended the Eighth International Grasslands Conference at Reading and the International Soil Science Congress at Wisconsin. During his four-months trip overseas Mr. Fricke is visiting research institutions in Europe, England, North America and New Zealand.

Branch Notes

Australian Capital Territory

The following are the officers of the Society for the year 1959-60. President, Dr. R. N. Robertson; Secretary, Dr. L. H. May, Treasurer, Dr. L. G. Paleg; Committee members: A.C.T., Dr. N. P. Kefford; Q'ld., Dr. G. L. Wilson; N.S.W., Dr. J. F. Turner; S.A., Dr. P. Brownell; Tas., Dr. D. M. Paton; Vic., Dr. T. F. Neales; W.A., Professor B. J. Grieve. The Annual Meeting of the Branch was held in February when the following were elected:

President and Delegate: *Dr. O. H. Frankel.*
Vice-President: *C. W. Strutt.*
Hon. Secretary: *Dr. J. R. McWilliam.*
Hon. Treasurer: *Dr. B. D. H. Latter.*
Hon. Asst. Secretary: *K. D. Woodyer.*
Hon. Sub-Editor: *D. V. Walters.*

Committee Members: *A. F. Gurnett-Smith, Dr. R. O. Slatyer, W. D. Hardy.*

The retiring President, Dr. R. D. Brock, in his Presidential Address, surveyed the first 25 years of the Institute. He pointed out that at least two of the objectives of the Institute conflicted—to have a voice in the affairs of the nation, and to further the interests of Institute members (the trade-union attitude to membership).

He suggested that future policy of the Institute should be to select projects which it was capable of completing rather than projects which later on would be taken over by, say, the Agricultural Council. We should choose wisely, and act decisively.

New South Wales

At the annual general meeting held in February the following office-bearers were elected:—

President—*Mr. C. I. A. Beale*
Immediate Past President—*Mr. A. J. McIntyre*
Vice President—*Dr. B. G. Davey*
Secretary—*Mr. J. B. Truscott*
Treasurer—*Mr. D. L. Jackson*
Assistant Secretary—*Mr. R. W. Condon*
Assistant Treasurer—*Mr. F. McMullin*
Principal Delegate—*Mr. A. N. Johnston*
Sub-Editor—*Mr. G. Alexander*
Committee members—*Miss H. Wrigley, Mr. E. J. Jacob, Mr. K. R. Green, Mr. R. McLeod*
Publicity Officer—*Mr. W. Ritchie.*

At this meeting, members expressed extreme dissatisfaction with Central Office activities and efficiency, and with Council activities; the branch resolved to examine these complaints during the year. Mr. McIntyre delivered his presidential address entitled "Agricultural Outlook in the 1960's."

"The Efficient Use of Fertilizers" was the title of a symposium held in March. Mr. F. C. Crofts spoke on nitrogen fertilizers, Dr. A. J. Anderson on phosphorus and sulphur fertilizers and Mr. J. Fisher-Pollard on potassium fertilizers.

In June, a symposium on "Agricultural Education" attracted a large audience. The meeting was addressed by the following well known figures:—Professor C. A. McRae, Deputy Vice-Chancellor of the University of Sydney; Professor G. L. McClymont, Dean of the Faculty of Rural Science, University of New England; Mr. P. G. Price, Deputy Director General, N.S.W. State Department of Education; Mr. H. R. Richardson, Principal Hawkesbury College; Professor J. R. A. McMilan, Dean of the Faculty of Agriculture, University of Sydney.

Other functions included a welcome to New Graduates in May. As usual, members were poorly represented; 15 were present and 45 new graduates, including 2 from the School of Wool Technology. Plans are also in hand for the celebration in August of the 50th year of the Faculty of Agriculture and the 25th year of the Institute. A move to sponsor a Southern Sub-branch was unsuccessful; Southern members did not want a Sub-branch.

At the committee level, eleven sub-committees are or have been in operation; they deal with the following—membership, programme, undergraduate affairs, newsletter, extension, ethics, film appraisal, publicity, deputations, institute affairs and the forthcoming Jubilee celebrations. A revised code of ethics designed to include farm advisers was submitted to Council and two other reports on Institute Affairs and Agricultural Extension will be submitted soon. The enquiry into Institute affairs involved a questionnaire to N.S.W. members; only 30 per cent. replied, indicating the general apathy of most members.

Victoria

The twenty-fifth annual general meeting of the Branch was held at the School of Agriculture on May 27. The annual report and financial statements were adopted and the following members were elected to the committee for the ensuing year—

President (and Principal Delegate)—*H. R. Dickinson*
Vice-President—*R. S. Harper*
Immediate Past President—*R. E. Loder*
Hon. Secretary—*C. D. Kimpton*
Hon. Assistant Secretary—*T. W. Donaldson*
Hon. Treasurer—*B. C. Hanger*
Hon. Assistant Treasurer—*M. G. Hawson*
Ordinary Members—*W. R. Dickson, G. W. Douglas, W. Ives, P. T. Jenkins.*
Hon. State Sub Editor—*R. R. Hedding*
Hon. Recorder—*M. Savidge*
Professor of Agriculture (Ex. Officio)—*Prof. H. C. Forster*
Institute President (Ex. Officio)—*A. L. Tisdall.*

The retiring President Mr. R. L. Loder gave his Presidential address entitled "Woolgathering". This proved to be a most fascinating and informative account of the shearing industry, covering a host of aspects from the idiosyncrasies of the cook to the legal aspects of shearing awards.

The annual report presented at the meeting showed the branch to have a total of 498 members at December 31, 1959. It also indicated that a great deal of branch activity was due to the various sub-committees which functioned during the year.

At a meeting on July 23, Mrs. Edith Cooper gave a most interesting account of a recent visit she made to Russia. Mrs. Cooper, an Arts graduate of the University of Western Australia, is a well known sheep breeder at Tatyoon, Victoria. While in Russia she visited a number of agricultural districts and spent some time at a State Sheep Farm and at the Central Ukraine Cattle Research Station.

The Branch has continued its practice of providing speakers to address schools on the work of agricultural scientists. Requests from many schools throughout the state indicate the value that is placed on this activity.

The committee has given considerable thought to the proposed Extension survey to be conducted by the Institute. It is considered to be an activity of considerable importance and the branch viewpoint has been submitted to Council.

Grasslands Society of Victoria

The Grassland Society of Victoria held its first conference at Burnley Gardens, Melbourne, on May 23-24. The first day took the form of a symposium on "The role of phosphate in Victorian grassland farming". Eight speakers contributed and a discussion period was held in the evening.

The following morning was devoted to a series of miscellaneous papers by members and a report by Mr. F. C. Crofts on the work being done on winter feed production at the Sydney University farms.

The conference, which was attended by 160 people, was officially opened by the Director of Agriculture, Mr. P. Ryan.

The addresses and speakers were:—

May 23.—

Official Opening. Mr. P. Ryan, Director of Agriculture.

The Role of Phosphate in Victorian Pasture Improvement. Mr. R. L. Twentyman, Senior Agrostologist, Department of Agriculture.

The Soil Scientists Viewpoint. Dr. L. H. P. Jones, C.S.I.R.O., Melbourne.

The Plant Nutritionists Viewpoint, Prof. J. S. Turner, Botany Department, University of Melbourne.

The Supply of Phosphorus Fertilisers. Mr. A. Q. Sinclair, General Manager, Commonwealth Fertilisers & Chemicals Ltd.

The Agrostologists Viewpoint. Messrs. R. J. Newman and J. P. Murphy, Agrostologists, Department of Agriculture.

The Economists Viewpoint. Mr. A. Lloyd, School of Agriculture, University of Melbourne.

The Farmers Viewpoint. Mr. N. O. Gubbins, Birregurra, Victoria.

May 24.—

More Winter Feed from Pastures. Mr. F. C. Crofts, University of Sydney.

The effect of stocking rate on the efficiency of fat lamb production. Dr. D. E. Tribe, School of Agriculture, University of Melbourne.

Rates of stocking trial at Bengworden. Messrs. F. Drake and N. M. Elliott, Department of Agriculture, Bairnsdale.

The use of herbicides in (pasture) renovation. Mr. L. W. Smith, I.C.I., Croydon, Victoria.

The society is publishing the proceedings of this conference.

At the March Council meeting of the Australian Institute of Agricultural Science the Grassland Society became affiliated with the Institute. The Society looks forward to a valuable association between the two bodies.

Queensland

The 25th Annual General Meeting of the Branch was held at the Chamber of Manufacturers, Wickham Terrace, Brisbane on March 23, 1960.

The officers elected for 1960 were as follows.

President — *Mr. F. Chippendale,* Plant Nutrition Section, Department of Agriculture and Stock.

Vice-Presidents—*Dr. G. L. Wilson,* Botany Department, University of Queensland.

Mr. O. W. Sturgess, Plant Pathology Section, Bureau of Sugar Experiment Stations.

Secretary—*Mr. A. Johnson,* Plant Nutrition Section, Department of Agriculture and Stock.

Asst. Secretary—*Mr. F. From,* Agriculture Department, University of Queensland.

Treasurer—*Miss D. Nunn,* Sheep and Wool Branch, Department of Agriculture and Stock.

Committee Members—*Mr. A. C. Arvier,* Imperial Chemical Industries of Australia and New Zealand.

Dr. E. M. Hutton, Division of Tropical Pastures, C.S.I.R.O.

Mr. S. A. Waring, Agriculture Department, University of Queensland.

Branch Editor—*Dr. B. R. Champ,* Entomology Branch, Department of Agriculture and Stock.

The retiring Branch President, Mr. O. W. Sturgess, delivered for his Presidential Address "The Branch in Retrospect and Prospect."

The April ordinary general meeting was held at the C.S.I.R.O. Cunningham Laboratory, St. Lucia on April 20 and opportunity was taken to inspect the laboratories and glasshouse facilities of the newly established Division of Tropical Pastures. Dr. E. M. Hutton, Acting Chief of the Division, outlined the work of the Division and Mr. G. Hubble then described the function of the Division of Soils which has officers based in the Cunningham Laboratory. Three C.S.I.R.O. Officers then reported on some of the projects currently being undertaken at the Laboratory—Mr. N. Shaw spoke on "Spear Grass", Dr. A. Martin on "Soil Fertility", and Mr. C. S. Andrews on "Radioactive Isotopes and Their Role in Plant Nutrition Investigations".

Following an offer by the C.S.I.R.O. Cunningham Laboratory to make available their lecture room for meetings of the Queensland Branch of the Institute, the Branch decided to change the venue of ordinary meetings from the Chamber of Manufacturers on Wickham Terrace to the Laboratory until further notice.

The May ordinary general meeting was held at the Cunningham Laboratory on May 25. The main business of the evening took the form of a discussion on *"Sorghum almum"*. Mr. B. C. Clarke of "Nunbank", Taroom, dealt with *S. almum* from the primary producers' point of view of Mr. L. A. Edye of the C.S.I.R.O. at Lawes spoke on some characteristics of the plant.

The June ordinary general meeting was held at the Cunningham Laboratory on June 22. The evening was devoted to presentation of Notes and Exhibits. Contributors were:

Mr. J. R. Blake—Performance of an imported fan unit for fruit and vegetable transport;

Mr. R. C. Colbran—Two new nematode records for Queensland;

Mr. H. M. Groszmann—Diversity with *Phascolus vulgaris;*

Mr. P. C. Kriedeman—The effects of nitrogen and phosphorus on cyanogenesis in *Sorghum almum.*

The July ordinary general meeting was held at the South Queensland Tobacco Growers' Co-operative Association Ltd., at Northgate on July 20. Following an inspection of the selling floor three speakers described various aspects of the tobacco industry:

Mr. Jennings of W. D. & H. O. Wills discussed "Tobacco Quality from the Buyers' View Point";

Mr. K. Martin, Secretary-Manager of the S.Q.T.G.-C.A. spoke on "Organised Marketing in Australia", and finally

Mr. J. Winterton, an Agronomist of the Queensland Department of Agriculture and Stock, dealt with "Some Agronomic Problems in Tobacco Production".

South Australia

The Annual General Meeting was held at the Waite Institute on February 5, when the following members were elected office bearers in the 1960 committee:—

President: *Mr. J. C. M. Fornachon.*
Vice-President: *Mr. P. C. Angove.*
President Elect: *Mr. T. C. Miller.*
Hon. Secretary: *Mr. G. R. Edwards.*
Hon. Assistant Secretary: *Mr. E. W. Boehm.*
Hon. Treasurer: *Dr. B. G. Coombe.*
Hon. Sub. Editor: *Dr. P. F. Brownell.*
Committee Members: *Dr. A. J. Brink, Dr. K. W. Finlay, Mr. M. R. Krause.*
Hon. Auditors: *Mr. M. B. Spurling, Mr. P. Judd.*

The Branch Prize for the most distinguished student completing the course in Agricultural Science was presented to Mr. J. A. E. Cooke at the Annual General Meeting. He has been appointed as a Research Officer in the Horticultural Branch of the Department of Agriculture.

Mr. P. C. Angove's Presidential Address, Extension as a Process was of much interest and led to keen discussion.

At the Branch meeting held on March 25, Mr. N. S. Tiver, Senior Agronomist in the Department of Agriculture spoke on The Riddle of the Sands. He described research on the establishment of pastures in the deep sands of the South East of South Australia.

At a Branch meeting held on April 29 Dr. B. G. Coombe, Lecturer in Plant Physiology (Horticulture), Waite Institute, spoke on Californian Grape Production—an example of modern specialised agriculture.

Dr. P. B. Cornwell, who is the leader of the Entomology Group in the Isotope Research Division in the United Kingdom Atomic Energy Authority, gave an address at a Branch Meeting held on June 17. He spoke on the control of insects by use of radioactive substances.

Western Australia

The February meeting was addressed by an industrial psychologist, Mr. F. R. Ware, who spoke on Personnel Management. His talk followed criticism of the standard of administration by agricultural scientists, and drew strong interest and a big attendance. Spirited discussion followed the talk, and is appeared that most members present favoured some sort of in-service training in administration.

The March meeting was also well-attended, the main interest being in a symposium organised to discuss the perfect pasture plant for the Mediterranean environment. This was addressed by Dr. L. C. Snook who discussed animal needs and utilisation, E. N. Fitzpatrick, who spoke on the soils and environment and E. T. Bailey, who reviewed the plants available.

The symposium indicated a change in our approach to pasture plants and their utilisation, with a swing in favour of deep rooted perennials which will make more use of limited moisture supplies and extend the season when good grazing is available, rather than high-producing annuals which give a higher production but a smaller spread.

At the Annual General Meeting held on April 22 Mr. N. Halse was elected President of the W.A. Branch for the coming year. Other major office bearers: Vice President, E. J. Underwood; Secretary, E. N. Fitzpatrick; Treasurer, T. Stoneman.

At the May meeting Mr. R. T. Lange spoke on the effects of native Rhizobia on cultivated lupins in Western Australia. Some of these organisms have been found to form symbiotic associations of varying effectiveness with lupin species cultivated in Western Australia. Where these are ineffective the association can have adverse effects on the establishment of this important species. Mr. Lange, now at Cornell University, U.S.A., discussed research carried out at the Institute of Agriculture, University of W.A. during the last few years.

A well-attended June meeting was addressed by Mr. M. J. Mulcahy, research officer with CSIRO. He presented a paper on soil formation and distribution in Western Australia, based on an intensive study of soils in the York district. As some of these soils are of major economic importance the meeting drew great interest.

A branch of the Australian Agricultural Economics Society has been formed in Western Australia, and the Institute branch decided to support its inaugural meeting on July 21 instead of holding a formal July meeting. This successful meeting took the form of a forum on Western Australia's Agricultural and Industrial Development and the Export Drive, chaired by the Hon. Charles Court, Minister for Industrial Development in the State Government and addressed by Prof. I. Bowen, Professor of Economics University of W.A.; Mr. Grant McDonald, General President of the Farmers Union of W.A.; and Mr. B. MacKinlay, President of the W.A. Chamber of manufactures.

Farmers' and Scientists' Joint Conference: As a result of pressure from various sources the branch has agreed to hold one more Joint Conference in 1961, but the Farmers' Union has agreed that after this the conference should not be an annual affair. Due to the heavy burden of work on a few members the branch did not favour holding another conference until 1962.

The Proceedings of the last conference have been available for some time. Like previous proceedings the booklet is well produced, and a useful contribution to agriculture—and farmer-scientist co-operation in Western Australia. Any interested Institute members should be able to obtain copies through the W.A. Branch.

Papua and New Guinea

On June 10, 1960 the inaugural meeting of the Institute's eighth Branch was held at Port Moresby —the Territory of Papua and New Guinea Branch.

Elections were held for office bearers for the year 1960 with the following results:

President—*Mr. F. C. Henderson*
Vice President—*Mr. C. K. Graham*
Secretary—*Mr. J. C. Lamrock*
Treasurer—*Mr. S. P. Saville*
Committee—*Dr. Dorothy Shaw, Mr. D. W. P. Murty, Dr. J. Szent-Ivany.*

Due to the unique conditions in the Territory the Committee is giving special consideration to the Branch's Bylaws and operating conditions.

The inaugural meeting fixed the total subscription to be paid by its members at £5 for 1960. An advance of £25 for operating capital was made to the new Branch by Council.

The members of the P. & N.G. Branch are at present:—

Formerly of the N.S.W. Branch:

Barrie, J. W.—Pt. Moresby
Bridgland, L. A.—Rabaul

Catley, A.—Rabaul
Doumany, S. S.—Kavieng
Edwards, C. S.—Lae
Henderson, F. C.—Pt. Moresby
Morgan, T. R.—Pt. Moresby
Murty, D. W. P.—Pt. Moresby
Peterson, A. S.—Pt. Moresby
Pulsford, R. L.—Rabaul
Saville, S. P.—Konedobu
Shaw, D. E.—Pt. Moresby
Trinick, N. J.—Konedobu
Formerly of the Victorian Branch:
Allen, P. B.—Kundiawa
Carne, R. S.—Rabaul
Edwards, D. S.—Henganofi
Henty, E. E.—Lae
Montgomery, I. Y.—Pt. Moresby
Formerly of the S.A. Branch:
Byrne, P. N.—Rabaul
Williams, B. G.—Pt. Moresby
Formerly of the A.C.T. Branch:
Keleny, G. P.—Pt. Moresby
Formerly of the Q'ld. Branch:
Aland, F. P.—Pt. Moresby
Barrett, J. H.—Aiyura
Graham, G.—Pt. Moresby
Hartley, A. C.—Pt. Moresby
Jamieson, G. I.—Lae
O'Donohue, J. B.—Rabaul
Schindler, A. J.—Lae
Szent-Ivany, J. J. H.—Pt. Moresby
Formerly of the W.A. Branch:
Asher, C. L.—Bereina
Baseden, S. C.—Rabaul
Browne, J. F. S.—Pt. Moresby
Cole, K. S.—Samarai
Newton, K.—Rabaul
Ramm, P. D.—Pt. Moresby
Stallwood, P. L.—Bereina

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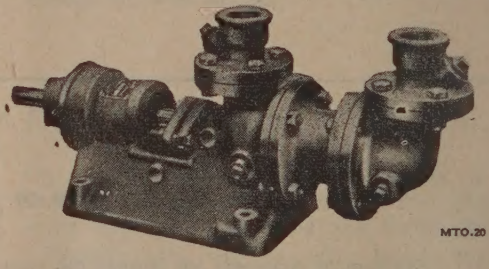

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